S. HRG. 101-861

THE ROLE OF NUCLEAR ENERGY IN MEETING FUTURE ELECTRICITY DEMANDS

HEARING

BEFORE THE

SUBCOMMITTEE ON NUCLEAR REGULATION

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

SECOND SESSION

AUGUST 1, 1990

Printed for the use of the
Committee on Environment and Public Works

U.S. GOVERNMENT PRINTING OFFICE

33-745 WASHINGTON : 1990

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

E321 .18

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

QUENTIN N. BURDICK, North Dakota, *Chairman*

DANIEL PATRICK MOYNIHAN, New York	JOHN H. CHAFEE, Rhode Island
GEORGE J. MITCHELL, Maine	ALAN K. SIMPSON, Wyoming
MAX BAUCUS, Montana	STEVE SYMMS, Idaho
FRANK R. LAUTENBERG, New Jersey	DAVE DURENBERGER, Minnesota
HARRY REID, Nevada	JOHN W. WARNER, Virginia
BOB GRAHAM, Florida	JAMES M. JEFFORDS, Vermont
JOSEPH I. LIEBERMAN, Connecticut	GORDON J. HUMPHREY, New Hampshire
HOWARD M. METZENBAUM, Ohio	

DAVID M. STRAUSS, *Staff Director*
ROBERT F. HURLEY, *Minority Staff Director*

SUBCOMMITTEE ON NUCLEAR REGULATION

BOB GRAHAM, Florida, *Chairman*

DANIEL PATRICK MOYNIHAN, New York	ALAN K. SIMPSON, Wyoming
HARRY REID, Nevada	STEVE SYMMS, Idaho

CONTENTS

OPENING STATEMENTS

	Page
Graham, Hon. Bob, U.S. Senator from the State of Florida	1
Reid, Hon. Harry, U.S. Senator from the State of Nevada	4
Simpson, Hon. Alan K., U.S. Senator from the State of Wyoming	2

WITNESSES

Flavin, Christopher, vice president, research, World Watch Institute	16
Prepared statement	88
Gent, Michael R., president, North American Electric Reliability Council	12
Prepared statement	68
Stuntz, Linda G., Deputy Under Secretary for Policy, Department of Energy	6
Prepared statement	41
Taylor, John J., vice president, nuclear power, Electric Power Research Institute	13
Prepared statement	70
Wilson, Michael, chairman, Florida Public Service Commission	10
Prepared statement	62

THE ROLE OF NUCLEAR ENERGY IN MEETING FUTURE ELECTRICITY DEMANDS

WEDNESDAY, AUGUST 1, 1990

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON NUCLEAR REGULATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:37 a.m., in room 406, Dirksen Senate Office Building, Hon. Bob Graham [chairman of the subcommittee] presiding.

Present: Senators Graham, Simpson, and Reid.

OPENING STATEMENT OF HON. BOB GRAHAM, U.S. SENATOR FROM THE STATE OF FLORIDA

Senator GRAHAM. Good morning. This is my first meeting as chairman of this subcommittee; in fact, it is my first meeting as a member of this subcommittee, so hopefully, I am going to be on a fast learning curve.

I appreciate the people who have joined us today in order to contribute to that personal goal as well as to our subcommittee's goal. We are joined today by our ranking member and former chairman of this subcommittee, Senator Simpson of Wyoming, and Senator Reid of Nevada, both of whom have had long-time interest, background, wisdom, and involvement in this issue.

This is the first of a series of three hearings that this subcommittee will be holding on the future of nuclear energy. The nuclear energy issue will play a significant role in meeting this Nation's energy future. Approximately 110 reactors today supply around 20 percent of the Nation's electricity. For the most part, the electricity supplied by nuclear energy has been safe, reliable, and economical. In my State of Florida, we have had a very good experience with nuclear energy. However, this has not always been the case. Mistakes have been made in building and operating reactors; some plants have been very expensive; there has been one major accident. We still do not have a solution to the problem of nuclear waste.

At present, there does not appear to be a consensus on whether or how to proceed with the development of nuclear energy in this country. Critics of current technology contend that nuclear power is too expensive, too dangerous, that no more plants should be built until the technology is made smaller and safer. Many people believe that we should not build any more plants until the waste problem is solved. This viewpoint is supported by the fact that no

new plants have been ordered since 1978. It is clear that new generation capacity of some type will be needed, whether it is nuclear, coal, gas, solar, or some other technology. The Clean Air Act, when passed, will make the use of coal less attractive as one of these options. Consideration of the greenhouse effect will make the use of all fossil fuels less attractive. To make nuclear more acceptable, the nuclear industry is working to develop safer standardized designs. In light of these factors, many believe that we should build new nuclear plants to meet this Nation's increasing demand for electricity in an economical and environmentally sound manner. Clearly, whether nuclear power will or should play an increasing or diminishing role in our future will depend upon a mix of economic, environmental, and political factors.

At the hearing today, we will begin to examine some of the external factors affecting the future of nuclear power such as the demand for electricity, and environmental concerns. Today's witnesses will discuss the projections for electricity demand in the 1990s and beyond, and how utilities are planning to meet this demand. Today's witnesses will also discuss the affect of environmental considerations upon the choice of generating technologies. We will consider the role of nuclear power against this background.

In two more hearings later this fall, the subcommittee will examine some of the internal factors affecting the future of nuclear power. The second hearing will concern the standardization of nuclear powerplant designs and the effectiveness of the process for licensing nuclear powerplants. The third hearing will examine the Federal program for the disposal of high-level nuclear waste. I hope that these hearings will provide the subcommittee with suggestions for legislative or oversight activities to improve the safety, reliability, and acceptability of nuclear energy. As the subcommittee considers these and other issues, I would hope to have the privilege of advice and counsel from the distinguished members of this subcommittee, especially Senator Simpson. Senator Simpson has chaired this subcommittee for a number of years, has a true wealth of experience in this area, and I look forward to working closely with him, drawing upon his knowledge, and continuing the bipartisan spirit which has characterized this subcommittee.

At this time I would like to welcome our witnesses to the hearing. We will be hearing today from Ms. Linda Stuntz of the Department of Energy, Mr. Michael Wilson of the NARUC Subcommittee on Nuclear Issues in the Florida Public Service Commission, Mr. Michael Gent of the North American Electric Reliability Council, Mr. John Taylor of the Electric Power Research Institute, and Mr. Chris Flavin of Worldwatch Institute.

We are joined today by Senator Simpson and Senator Reid. Do you have an opening statement, Senator Simpson?

OPENING STATEMENT OF HON. ALAN K. SIMPSON, U.S. SENATOR FROM THE STATE OF WYOMING

Senator SIMPSON. Mr. Chairman, I thank you very much. I really do look forward to working with you. It is a pleasure to serve with you. I've been on this subcommittee since I wandered into this place in 1979, and as you might imagine, I had been here six to

eight weeks and all of a sudden Three Mile Island happened. Senator Gary Hart was chairman, I was ranking member, and that was a remarkable experience for a baptism. So it's been good to watch you and Senator Reid come onto the committee. I know your great interest is very real, and I'm going to enjoy working with you. John Breaux did a splendid job, and I know you will do the same. Indeed, Gary Hart and I always worked closely together in a nonpartisan way. We put together the high level nuclear waste proposal which was later disassembled because of politics.

So it is a tough one and the agenda is much the same when you talk about demand and supply, and we are going to go to standardization, those are critical things, and high-level nuclear waste. Everybody can talk about that all they want to but the issue is, what are we going to do with it? The sooner politicians quit getting elected on the basis of pounding their chests and just saying nothing, then we will finally get a national agenda that will be somewhat bright.

But anyway, I think these hearings are at a good time when these energy needs are so important in our daily lives and for the future of the Nation's economic stability and growth. We saw just last week Chicago with a serious blackout from a fire in a generating station, then looting, which is a hideous aspect of it. The blackout lasted for several days, destruction of a block of businesses by a gas leak, those are energy sources.

The Washington Post had a feature article on power shortages in this area. I think those stories highlight some of the real challenges we face. I think blackouts and brownouts are going to be more and more frequent. No energy source is risk free; each source has its advantages and disadvantages, uncertainties, and risks. There is no risk-free world, and we certainly ought to be sobered up on that. We have to consider our national and global responsibilities. While we have choices, Mr. Chairman—and I like the closing phrase in the Washington Post article; Mr. Trigoomas, Executive Vice President of the Potomac Electric Power, said, "We want it all." He says, "ice cream and no hard trouble, power and no facilities." And that is where we are.

But if we don't get honest and serious, then we are going to be in deep trouble. He said, "If we don't get a little brighter, we'll soon be cursing the darkness." But knowing how politics work, we'll also be cursing those who brought it upon us, and those who have delayed the most are going to get the worst backlash.

I am a conferee on the Clean Air Act, so here we go on that. There is another aspect of the external forces at play in deciding which energy sources to use. We see the aspects of risk-free air toxics, ozone non-attainment, SO_2, NO_x, and everyone wants to do something, but, it isn't good enough for the purists, and hopefully they join hands with the soot-covered slobs that don't want to do anything and meanwhile we don't get anything done.

So have fun, and I'm going to help you, I promise. I remember my rating with the nuclear industry when I was chairman; I was 60 percent, so I knew I was doing something right. If it had been any higher than that I would have been spooked, because you show me a 100 percenter and I'll show you a guy I want to stay away from. Maybe we can get something done and I pledge to help.

I think this is very important. Our job is to steer between the extremists on both sides of every issue we deal with in this subcommittee. I pledge to do that, I really mean that. I'll look forward to working with you. I hope that the nuclear option and the coal option and the natural gas option can at least be considered honestly and seriously and sincerely and fairly. I look forward to working with you as we continue the remarkable jurisdictional duties of this subcommittee, and I think it is just great that this is your first hearing as chairman of the subcommittee. I pledge my support and assistance to you.

Senator GRAHAM. Thank you very much.

Senator Reid.

OPENING STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

Senator REID. Mr. Chairman, I appreciate this hearing being called. I think the subject matter is timely. I also want to say just a word. I am especially impressed with the job that I know that you can do. I think it is important that we can call upon your experience as a Governor; I think it will give this committee a unique perspective because you've dealt with the problems from an administrative standpoint on a State level. So I think you have all the abilities in the world to make this the most meaningful and important subcommittee.

First of all, I would like to compliment you on these background hearings that will benefit our appreciation of the nuclear fuel cycle, the regulatory environment, and the role that nuclear power can play in the future of America. Given the unhealthy state of the nuclear power sector over the last decade—and I've read each of the statements and certainly I think there is general agreement to that effect that the nuclear power industry has not been healthy this past decade—it is worthwhile to seek new perspectives and innovative solutions to the ills that face this industry. I think for this reason it is beneficial to develop a record on the opportunity for nuclear power to play a significant role in the energy mix and the steps that need to be taken to achieve such a goal.

To be successful, it is important that the illness afflicting the nuclear option be addressed rather than the symptoms. I'm sure that the work of the subcommittee will continue to provide high quality oversight of the real regulatory issues affecting the Nuclear Regulatory Commission and the public. I'm looking forward to working with you, as Senator Simpson has indicated.

The mission of the NRC is essential to ensure the health and safety of the public. Nuclear safety and quality performance cannot be taken for granted by the industry. It is gratifying to be aware of changes in the mindset and that complacency and poor work habits are becoming a thing of the past. This is not just another way, in effect, to boil water. If nuclear energy is to continue to contribute to the Nation's energy mix, it appears to me that fundamental changes are needed not only to the hardware the industry offers for tomorrow but to the regulatory framework that exists today and to the management of yesterday's waste, and also the information that is provided to the public.

Mr. Chairman, a number of these problems are being addressed. As examples, the industry's prior reference to inherently safe advance reactor designs and the NRC's efforts towards standardization, license reform, and life extension have progressed beyond the talking stage. There are those serious matters that require attention rather than merely lip service. The avoidance of decisionmakers to technically resolve the waste issue and the industry's inability to communicate with the public will inhibit progress towards acceptance of the nuclear option. The confidence of the public with respect to nuclear power has been shaken at its foundations and the trust built up over generations sits fractured in full view. It is conceivable that the public's trust and good will has been irreparably harmed over the last dozen or so years, and the unsightly patchwork surface repairs may not be effective measures to rejuvenate the nuclear option as a significant player in the Nation's energy mix. If the industry is at all serious, there is much work to be done.

There have been no new orders for nuclear powerplants since the mid-1970s. And of the few remaining units in the pipeline, all have troubled pasts. The likelihood that more than one-third of the remaining units under construction ever operates, I think, is wishful thinking. This does not bode well for an industry seeking a rebirth. Given the insatiable lust for power that exists in America, we are closing in on a threat to our Nation's security. Typically, electrical demand is greatest during the heat of the summer. Brown-outs and rotating blackouts that were necessary during the cold snap last winter illustrates the fragility of our Nation's electrical supply. It is certain that our total electrical capacity margin has been dropping since the early 1980s and if it continues on this pace, this margin is likely to fall below the minimum reserve margin, some 20 percent by the mid-1990s. There is little doubt that significant new capacity will be needed in addition to extending the life of existing plants by repowering or otherwise improving performance or efficiency. Nevertheless, there are other nations to meet the Nation's future energy demands.

Conservation load management, thermal storage, and renewable energy sources need to be factored into the Nation's energy strategy. With the attention being afforded to climate change or global warming, the theme of sustainable development needs to be revisited. Sustainable development was defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. This principle can be applied to every segment of man's activities including housing, agriculture, manufacturing, transportation energy. The nuclear option does not produce greenhouse gasses and, the argument goes, does not contribute to global warming; therefore the argument goes on. It is a viable alternative to fossil fuel power plants. This time it is not apparent to me that the nuclear option comports with the goal of sustainable development. Until and unless the waste issue is technically resolved without compromising the opportunity for future generations, I believe that the future is dim.

Mr. Chairman, I am not going to use this as a platform to debate the nuclear waste issues. Senator Simpson has heard those numerous times, and he is absolutely right. The work done in the 1982

Act was good. The more we look at the 1982 Act, the more merit we see in that Act. We know that for political reasons that was taken away from the Congress and the country, and I think that is too bad. As I said, I'm not going to harp on the nuclear waste issue at this hearing; the statements of some of today's witnesses address the problem of nuclear waste disposal. I would think that we have to look at alternatives to what is now being deemed as the only alternative.

The Nation's energy supply is crucial to maintaining a vibrant economy and maintaining the quality of life as we know it today. It can no longer be taken for granted. So as the new Chairman of this subcommittee, I can think of no better place to start than determining what the future holds for things nuclear. As I indicated to you yesterday, Mr. Chairman, I have a matter on the House side that I've got to testify on. I do have staff people here because this hearing is important not only to the country, but the State of Nevada has a very important, we feel compelling, interest in this hearing. Thank you for calling such a timely hearing.

Senator GRAHAM. Thank you, Senator.

We are going to be holding this hearing today with a relative degree of informality in this workshop setting in order to allow for the fullest exchange of ideas and questions among the panelists as well as questions from Senator Simpson and other members of the subcommittee and myself. All of your prepared statements will appear in full in the record. At this time I would call on each of you in the order listed on the witness list to make an opening statement. I would encourage you to attempt to summarize your opening statements in the range of five minutes so that we can proceed to an informal discussion.

Let's begin with Ms. Linda Stuntz, Deputy Under Secretary for Policy, Planning and Analysis, U.S. Department of Energy.

STATEMENT OF LINDA G. STUNTZ, DEPUTY UNDER SECRETARY FOR POLICY, PLANNING, AND ANALYSIS, DEPARTMENT OF ENERGY

Ms. STUNTZ. Thank you, Mr. Chairman. I will try to be brief. I appreciate the opportunity very much to appear before you today to discuss the Department of Energy's views on the outlook for U.S. electricity supply and demand, and the potential role nuclear power may play in meeting that demand. I agree with all the opening statements; these are critical issues most worthy of the subcommittee's attention.

I think a good place to start is where we get our electricity from today. I brought some charts with me that I hope will make it possible to talk less and convey the maximum amount of information efficiently.[1] As you can see from that chart, we currently get about 55 percent of our electricity from coal; about 20 percent from nuclear; renewables, which include hydro in that chart, about 11 percent; natural gas, 9 percent; and oil, 5 percent, most of that is used in the northeast, as you might imagine.

---

[1]The charts referred to are contained in Ms. Stuntz' prepared statement.

Let me now turn quickly to what we think about the future starting with total energy demand. I think it is useful to do that and work back to electricity because there are some interesting differences in the trends. Projecting energy demand accurately is no easy task, as those of you who are veterans of this committee well know. Prior to the early 1970s, the growth rate of aggregate energy demand was about equivalent to the growth rate in GNP. However, for the period from 1973–1986, you did have the two oil shocks. There was virtually no increase in total U.S. demand for energy while GNP grew nearly 35 percent. Now the energy growth rates in Chart 2 are based on the assumption that GNP increases at an annual rate of 2.6 percent between 1990 and 2010, and a lower annual growth rate of 1.8 percent between 2010 and 2030. If future energy demand growth were to move in parallel with that GNP growth, as has been the case since 1986, even with these modest projected GNP growth rates, annual energy use would more than double over the period from 1990 to 2030. That would be basically where that top red line goes off the top of the chart. However, we do expect that innovations, continued or aggressive conservation, and structural changes in the economy will allow us to grow economically without energy use marching lockstep with GNP. That is why the area of blue, actual new energy supply, we expect to be demanded.

Based on the assumptions that we are now making in our recent National Energy Strategy reference case, and I want to emphasize most recent because this is an evolving process and we are learning, we expect total energy consumption in 2030 to be only about 136 quads, which would be 70 quads less than that top red line, what we would call the frozen energy efficiency. This is equivalent to an annual energy growth rate of about 1.2 percent from 1990 to 2030. That is hardly bullish; one of the big reasons for that is we would expect real improvements in energy efficiency.

Let me now turn to electricity and its share of total energy use. As I mentioned before, total U.S. energy use was flat between 1973 and 1986. Electricity consumption, however, tracked the growth in GNP even while other energy demand was relatively flat or falling. In 1970, electricity accounted for 24 percent of primary energy consumption in the U.S.; in 1990, we expect this figure to be about 36 percent, and, as shown in this chart, we expect this continued electrification of the economy to continue. By 2010, we think electricity will account for over 40 percent of total energy consumption.

We move now to chart 4. Where do we expect the electricity capacity to meet this demand to come from and when do we expect it to be needed? The Nation presently has about 700 gigawatts of installed electric generating capacity. Under the National Energy Strategy reference case, we would have to increase our generating capacity to about 920 gigawatts by 2010 to meet the forecasted increase in demand. The amount of new capacity needed, of course, depends not only on demand growth but on the extent to which existing capacity is retired or needs to be replaced. Much of our existing generating capacity came on line between 1965 and 1975 with a design life of about 40 years. Adding 40 onto 1965 and 1975 tells you that much of this capacity will need to be replaced or substantially refurbished soon after the year 2000. In this chart, existing

electricity capacity declines slowly because we do expect that there will be life extension of many coal-fired plants and of other plants as well.

In this chart, and I think most importantly for purposes of this hearing, we do assume, and incorrectly we hope, that existing nuclear plants are not life extended. We assume that because in this reference case—not our forecast but only a reference case, a jumping off point if you will—we have not included things that require policy changes from where we are today. Where we are today without policy changes of the sort now recently proposed by the Nuclear Regulatory Commission, nuclear plants are confined to the terms that they are licensed, about 40 years. That means that beginning in about the year 2010, when, we get to a later chart, we will see a substantial drop-off in nuclear capacity unless there is life extension.

We now turn to Chart 5, and I think we will pick up some of the points made in the opening statement. We thought it important to show you where we expect particularly the contributions to electricity demand we now project from renewables, conservation, and how that relates to what we expect to be necessary from traditional generation sources. The top wedge shows the decrease in demand that could result from additional conservation efforts even beyond those built into our reference case. The bottom portion shows the sizeable contribution, the yellow wedge there, the sizeable contribution of electricity that we expect could come from renewable technologies. In fact, we expect renewable capacity to increase from 99 gigawatts in 1990 to about 133 gigawatts in the year 2010.

The major feature of this chart, and I think it is very important for the subcommittee's purposes, is the remaining large wedge in the middle that has to be provided from traditional electricity generation supplies—oil, gas, coal or nuclear—even with we think aggressive efforts to promote renewable and conservation sources of supply.

In the near term, we expect that natural gas would be the fuel of choice for new electricity generating capacity. The natural gas share of the electricity generation fuel mix is expected to increase from about 9 percent in 1990 to 16.5 percent in the year 2000. However, since gas prices are projected in our current thinking to increase more quickly and more sharply over time than coal prices, coal-fired generation would become the economic choice for electric utilities around the year 2000 and would remain so thereafter. Assuming again the continuation of current policy to no policy changes, which in many ways makes this the least likely scenario because we know certainly for the period of time there will be policy changes, coal's share of fuel generation mix would grow from 50 percent in the year 2000 to 56 percent by 2010, and even higher in the year 2030.

Without new nuclear construction or life extension of existing nuclear capacity, nuclear generation would all but disappear by the year 2030. This could well happen because of continued nuclear regulatory and license uncertainties, financial risks, operating economies, inability to resolve the waste issue, and public opposition. If, on the other hand, current barriers to increase nuclear capacity can be overcome, nuclear power has the potential to supply

a large fraction of new generating capacity we will need between 2010 and 2030. As shown in this chart, with new nuclear units and nuclear plant life extension, nuclear power could comprise about 17 percent of electricity generation by 2010. This could rise to 27 percent by the year 2030.

Meeting restrictions on greenhouse gas emissions would require, obviously, greater alliance on low or non-greenhouse gas emitting technologies and the promotion of conservation-induced reductions in demand. If the current obstacles to nuclear power remain, the burden of meeting greenhouse gas reductions while satisfying the Nation's electricity requirements would fall very heavily on natural gas, renewable generation, and on demand-side efficiency investments. While these sources would certainly play an important role in our future electricity supplies, we seriously question whether exclusive reliance on these options would be a least-cost solution and would, in fact, provide the Nation with adequate economically-competitive supplies of electricity.

In conclusion, let me suggest it is important to look over the longer term as we are trying to do after 2030, not because we can forecast with precision what is going to happen over that period of time, but because we believe there are very important limits and trade-offs that need to be understood. Decisions that we make now about nuclear plant life extension, about waste, about design approval, will largely determine for the future and for a considerable period of time to come whether we will see growing nuclear generation capacity or an eventual decline in nuclear generation. I think it is extremely important that people understand what the consequences of those decisions would be. The majority of National Energy Strategy commentators addressing nuclear issues have taken the position that the Nation must retain nuclear power as an option for the future. However, it is also generally recognized that very widely held concerns about nuclear power must be addressed if the option is to be preserved and that clearly we have to do a much better job of educating the public about the risks, benefits, and costs involved.

As described in the interim report of the National Energy Strategy that was published by the Department on April 2, strong support has been expressed for the following goals for the nuclear sector. First, we need to maintain exact standards of safety, design, and operation of nuclear power plants and the related fuel-cycled facilities. Second, we need to demonstrate the technical capability to package, transport, and dispose of spent fuel and high-level waste in a timely, safe, environmental manner. Third, we need to improve the predictability and efficiency of the licensing process and regulation in general while protecting public safety. Fourth, we need to eliminate barriers to efficient and cost-effective operation of nuclear power plants and recycled facilities. Finally, to aid us in addressing these goals, we are analyzing a range of nuclear related options in the National Energy Strategy. We have not yet completed this analysis; however, the following three points are clear. First, if we are not going to construct any new nuclear power plants, we must prepare to identify and cope with the long-term implications of that action in terms of its impacts on the environment, electricity costs, and the reliability and adequacy of electrici-

ty service. Second, if we intend to retain the nuclear option, we must improve the licensing process for the power plants and related fuel cycling facilities to create a regulatory environment that is compatible with building plants again. Third, we must facilitate the deployment of new advanced nuclear power technology by developing reactors and fuel cycle systems with improved performance and improved safety margins.

Thank you very much. I look forward to our discussion later on these issues.

Senator GRAHAM. Thank you very much for an extremely helpful statement of the context in which we are going to be considering this issue.

Mike Wilson is Chairman of the Florida Public Service Commission and also chairs the Nuclear Subcommittee of the National Association of State Public Utility Regulators. Mr. Wilson.

STATEMENT OF MICHAEL WILSON, CHAIRMAN, FLORIDA PUBLIC SERVICE COMMISSION

Mr. WILSON. Good morning, Mr. Chairman and members of the committee. Let me first point out that I'm not appearing today as an official of NARUC or to present a formal position of that organization or a formal position of the Florida Public Service Commission. I would like to share with you some concerns and observations that I have. I think because of the rate of population growth and the consequent demand for electricity, the circumstances in the State of Florida may provide a useful back-drop for some of the points that I want to make.

Projections at this point show that Florida will need approximately 7,000 megawatts of additional power by the year 2000. Based on current projections, Florida will need almost 15,000 megawatts by the year 2010. Whether that need is met by conservation, utility constructed generation, cogeneration or other nonutility generation, Florida will need additional sufficient capacity equal to the size of the entire existing system of our largest electric utility, Florida Power and Light. Florida Power and Light is the fourth largest utility in the United States, and it presently serves 3.18 million people in cities such as Miami and Ft. Lauderdale. The equivalent of the power would be constructing a system to serve 20 cities the size of Tallahassee.

With aggressive conservation programs, Florida has been able to reduce the rate of growth per customer demand; although with the addition of an average of 190,000 customers per year over the last 10 years, overall demand has increased. When people move to Florida, they bring their electric needs with them. Through the 1980s, we saw increases in per customer demand; in the mid-1980s a leveling of demand; in recent years a resumption in the per customer growth rate in demand. During the next decade, we will continue to pursue aggressive conservation measures. We are also embarking on new programs of demand side management to attempt to control the growth of peak demand and we have accelerated installation of load management measures. However, conservation and load management measures alone will not overcome the need to construct new generation in Florida.

As I'm sure you know, during the Christmas holidays in Florida, we experienced extraordinarily cold weather. We faced electricity demand levels which were not anticipated to be reached until 1996, which goes to show you that predictions about demand, the only thing we know about them is the fact that they are usually wrong.

One of my duties as a public service commissioner is to assure that there is an adequate supply of electricity as demanded by customers of utilities in Florida. Utilities are required to come to the Commission for a determination of need for generating plants. We review the projected demand, but we also review alternative construction technologies and comparative costs. I find the range of choices narrowing, costs are increasing; there are serious drawbacks that exist to all generating technologies and fuel choices. The generating options available to Florida's utilities include solar, nuclear, coal, gas, and oil; and there are problems with each, particularly in Florida where we are at the end of any pipeline for fuel being an peninsular State.

It is difficult to evaluate the concerns about the environmental impact of combustion fuels without in the same breath considering the generation of power through nuclear fission.

As a regulator whose job it is to assure ratepayers an adequate supply of reliable, reasonably priced electricity, I am concerned that we have that supply of electricity. I have no emotional attachment to any source of electricity. Alternative sources of electric generation should be rationally appraised and evaluated and choices made according to the economics and societal costs. I am concerned with not having those choices available to be made.

In the generating expansion plans of Florida's electric utilities, not one includes nuclear generation. Nuclear power in 1989 provided approximately 22 percent of the generation in Florida, and approximately 20 percent nationwide.

The Federal Government and the Congress play a vital role in the role of nuclear power in this country. From the fabrication of fuel to the disposal of waste, the Federal Government controls the direction and vigor of the nuclear industry. As you examine the role of nuclear power, the areas into which you should inquire are fairly clear.

First, the licensing process must become more certain. The utility, its investors, Wall Street, State regulatory commissions, must know that a nuclear powerplant, once permitted for construction by the Nuclear Regulatory Commission, must carry with it the express commitment that if it is built according to specifications, it will receive a license to operate in a timely manner. No utility will order, and no State commission will authorize construction of a nuclear plant with open-ended liability on costs and design. There must be closure with construction licensing and operating licensing. You may also wish to consider imposing strict time limits on proceedings before the NRC. Florida's Commission has statutory time constraints on most proceedings by which all parties and the Commission are bound. This provides predictability and rational limits to the process.

Second, the Federal Government's responsibility for the disposal of high level nuclear waste must be fulfilled. Billions of dollars of ratepayers' money has been collected and billions spent in the frus-

trating pursuit of a disposal site. I am extremely encouraged by the Department of Energy's current efforts under the very capable leadership of its Secretary, Admiral Watkins. The Department has displayed an openness to outside counsel and advice, and has taken positive steps toward resolution of this problem.

But the most efficient and scientifically sound means of confronting the problem of high level nuclear waste may require the reconsideration of the role of a monitored retrievable storage system and the role of reprocessing of spent fuel.

The issues surrounding nuclear power in this country are serious and involve important considerations of energy independence, environmental damage, global warming/greenhouse effect, and potentially, America's competitive position in a world economy.

As a utility regulator, I want to have good choices available to me to meet the energy needs of the citizens of the State of Florida. While my statutory duties do not include environmental regulation, I am not unmindful of the threats to the quality of our environment, and I would like to meet that need with the most environmentally benign source of energy feasible.

If I, or NARUC, can be of any assistance in this committee's consideration of this subject, you have but to call on us. I appreciate the opportunity to come here today and to address you.

Senator GRAHAM. Thank you very much.

We will now hear from Mr. Michael Gent, President of the North American Electric Reliability Council.

STATEMENT OF MICHAEL R. GENT, PRESIDENT, NORTH AMERICAN RELIABILITY COUNCIL

Mr. GENT. Thank you, Senator Graham, it is certainly a mouthful to get that name out. I appreciate your willingness to hold such an informal hearing. What this does is open up to you many more experts around the country when they don't have to prepare fifty-page statements and things of that nature.

What I've submitted to you today is a page and a half statement. It is very short; it is also a very high cost item. This reflects the thinking of some 300-plus electric utilities in the United States and Canada, and what the issues are for providing a reliable supply of electricity over the next 10 years.

I have seven points that vary from environmental impacts to demand uncertainty. In trying to boil all of that down, I think the other members of this panel have said this as well, it boils down to what you think the demand is going to be over the next ten or twenty year period. If you think it is going to be three percent, then we don't have enough capacity on the boards; if you think its going to be two percent, we're just right; if it is going to be less than two percent, then we don't have to build some of the stuff in the pipeline or under plan.

In addressing your questions later today, I'm certain there will be some interest in the Clean Air Act, as your letter implied. I tried to look into some of the considerations, a number of highly regarded consultants and engineers have already testified or written papers, made speeches, and so on, on what the effects on electric utilities might be. It is not difficult to make capital calcula-

tions, but none of them to my knowledge have considered yet what the effect of these proposals might be on what I'll loosely call inter-utility trade. That translates roughly to what we call economy interchange; an exact calculation would be impossible without studies but I can assure you that the annual cost is in the billions of dollars.

With that I will close my comments and I would be more than happy to offer you my expertise or the expertise of the electric utilities of North America in answering your questions.

Senator GRAHAM. Thank you, very much.

Mr. John Taylor, Vice President, Nuclear Power, Electric Power Research Institute, Palo Alto.

STATEMENT OF JOHN J. TAYLOR, VICE PRESIDENT, NUCLEAR POWER, ELECTRIC POWER RESEARCH INSTITUTE

Mr. TAYLOR. Senator Graham, Senator Simpson, I appreciate this invitation to discuss the need for electricity and the role of nuclear power in meeting that need. With the committee's responsibility for addressing the environmental issues confronting our society, and this subcommittee's specific responsibility for oversight of the Nuclear Regulatory Commission, your interest in electricity supply and demand is certainly laudable since the use of electricity is one of the most effective means at our disposal for meeting and reconciling the environmental and economic objectives of the country.

Not fully appreciated is the fact that electricity has been a major factor in conserving energy which is an extremely important issue in contributing to assuring the effective availability of energy in the future. Linda Stuntz has already given you some figures; I'll simply back those with the comment that since 1920, while the fraction of primary energy used to produce electricity has increased from about 10 to over 35 percent today, the primary energy used to produce a unit of GNP has decreased by half. Despite the thermodynamic losses in the current means of producing electricity, the productivity gains electricity makes possibile through its ability to control electricity precisely in space, time and character, have contributed substantially to this energy conservation. There are many examples of these gains in all electric energy using sectors.

Wise use of electricity is also an important part of the solution to our environmental concerns because electricity is clean at its point of use. And control of waste by-products and emissions can be centralized at the powerplant and handled more efficiently. Of course, the fact that appropriate use of electric technologies increases the efficiency of overall energy use also reduces environmental impact. Electricity is the most flexible energy form. Its production can be based upon all the energy sources available to us. It uniquely enables new uses in fields such as medicine, and is fundamental of course to the information age.

Thus, because of the importance of electricity to a healthy society and productive economy, and electricity's value in achieving our environmental goals, it is important that we assure an adequate supply of electricity at reasonable cost and with environmental sensitivity.

The Electric Power Research Institute doesn't make independent projections of electricity demand, but I think you've heard already from Linda Stuntz the need for additional capacity and that conservation alone is not going to be sufficient to avoid building that capacity in some form. Many utilities are now beginning to add capacity to meet peak demands. The need for additional baseload capacity is also beginning to emerge, is likely to be widespread by the latter part of this decade which means that planning for such capacity should be starting now.

The energy sources available to us to meet these needs are natural gas, oil, coal, nuclear, hydro, and other renewables and geothermals. EPRI supports research and development to facilitate the use of all these sources. We also support the development of advanced transmission and distribution technology and more efficient electrical systems. In all cases, the need to minimize environmental impact is a key criterion in setting development objectives. Much of the capacity to be added in the 1990s will be fueled by natural gas. This is an appropriate course given the current economic and regulatory circumstances faced by the utilities, and the need to reduce our dependence on oil for reasons of national security and the trade deficit. However, as the country shifts more applications to the use of this most environmentally attractive of fossil fuels, there are concerns regarding the future availability of natural gas at reasonable prices.

Coal is the other fuel of choice for the 1990s and will continue as an important fuel into the foreseeable future. It is an abundant resource. New clean coal technologies will enable its use with far less environmental impact. Atmospheric fluidized bed combustion systems are now commercially available. Other clean coal technologies could be commercially introduced in the latter part of this decade. The technologies employing coal gasification will have significantly lower emission of SO_2, NO_x, and solid waste than a conventional pulverized coal unit with scrubbers. These technology advances also offer increased fuel efficiency. Increased fuel efficiency not only reduces costs and conserves energy, but it also reduces CO_2 emissions.

There have also been steady advances in technologies to use solar and wind energy. The unsubsidized cost of power from these sources is not yet competitive but it is ever closer. They are nearing a time when they may become economically feasible in regions of good solar or wind resources to supply peaking power. The technology for widespread use to replace fossil and nuclear power, however, is not yet in sight.

Thus, we come to nuclear power. Nuclear power supplied 20 percent of the nation's electricity demand, as you mentioned, Senator Graham, in your opening comment. Nuclear power produces no SO_2, NO_X, CO_2, or other greenhouse gasses. Emissions of radiation to the public can be controlled to virtually zero. It can be among the most economic means of producing electricity and is in many parts of this country and in other countries. We all know that no nuclear power plants have been ordered in the United States in more than a decade. Public concerns, regulatory uncertainty, and the consequent financial risk facing the utilities have led to this state.

The need to maintain a nuclear power option has increased in urgency recently for several reasons: the expected need for baseload electric generation in the late 1990s; the need to reduce air pollution caused by electricity production; an increased concern regarding the long-term effect of global warming.

To reopen the nuclear option, actions are required by the Government and industry. NRC has taken initial steps in improving regulatory stability through its standardization policy and the industry is working with the NRC to implement that policy effectively. The ultimate goal, and I'm underlining Mike Wilson's important statement, is the ability to obtain a combined construction and operating license which gives the utility the assurance that when it builds a plant in conformance with the construction permit, it can operate the plant without delay.

Institutional reforms are needed to achieve predictability in regulation and a restoration of the risk-reward balance in new plant investment, as Mike Wilson has already identified. And significant progress in radioactive waste disposal is clearly an essential.

From the viewpoint of industry, the utilities must have a strong sense of certainty in the safety, reliability, and performance, as well as a licensing process of future nuclear plants. To help to achieve that objective, the utilities, through EPRI and working with the Department of Energy and the Nuclear Regulatory Commission, are defining the safety and performance requirements for future plants. We have developed a very detailed set of requirements which the utilities will utilize as they subsequent move toward authorization and purchasing of new nuclear plants. These requirements substantially improve the safety of the systems, their simplicity, and their reliability, and their environmental compatibility. The document I have here is Volume I of an Executive Summary of those requirements which will be a foundation for the standardization of future advanced light water reactors.

Two types of light water reactors are now under high priority development by EPRI and its contractors in a joint program with the Department of Energy. The first is an evolutionary reactor with standardized design that can achieve substantial increases in safety and operational simplicity, increased lifetime reliability at longer life, reduced capital costs, shorter construction time, and lower operation and maintenance costs. These units will typically be of large output size, about 1,300 megawatts electric. The second effort is to develop smaller 600 megawatt electric reactors with all of the above features plus even greater simplification and passive safety features such as natural cooling mechanisms that rely on gravity and natural circulation as distinct from electric powered equipment to assure cooling of the core and its system in all cases.

Utilities expect that these ALWRs will be the vehicle for initial expansion of nuclear power electric generation capacity in the U.S. again. Because of their increased safety, reliability, and economy, they will strike the appropriate balance to meet the electricity and environmental needs of the Nation.

Two other advanced nuclear alternatives are also being pursued, primarily under DOE sponsorship, to achieve the full long-range potential of nuclear power. The modular high temperature gas-cooled reactor, which would extend the use of nuclear power to

heat process activities as well as electricity production; and the advanced liquid metal reactor, which would substantially improve the nuclear fuel supply by attracting more than 100 times the energy that is presently extracted from uranium by the existing LWRs.

It is of paramount importance that, as the Nation's leadership struggles to articulate environmental and energy goals, the role of nuclear power be recognized as one element in achieving those goals. Through the steps outlined above, with the support of the Congress and the Administration, nuclear power can once again be an important contributor toward meeting society's energy needs in a manner that is consistent with its environmental objectives.

Thank you, sir.

Senator GRAHAM. Thank you very much, Mr. Taylor.

Mr. Christopher Flavin, Vice President for Research, Worldwatch Institute, Washington, D.C.

STATEMENT OF CHRISTOPHER FLAVIN, VICE PRESIDENT FOR RESEARCH, WORLDWATCH INSTITUTE

Mr. FLAVIN. I think you put your finger on it in your opening statement when you suggested that economic, environmental, and political factors were going to determine the future of nuclear power.

It is my judgment in looking at trends, not only in this country but around the world, that the conditions in the 1990s and beyond are almost certainly going to be negative for nuclear power, and that we will, in fact, not see the kind of vast expansion that many in the industry would like to see.

I think there is a bit of a tendency for self-flagellation in this country about what we've done with nuclear power. In fact, we are only a leading indicator in a worldwide trend. There are less than 80 nuclear plants under construction worldwide today. Most of those will be completed in the next five years. The age of post-war nuclear expansion is very rapidly coming to an end, and you can point to different conditions—whether it be France or the Soviet Union or Germany—but clearly there is a nearly universal trend away from reliance on nuclear power to meet future electricity needs.

In looking at conditions that will affect nuclear power in this country, I think the place to start really is with electricity trends and growth trends and some of the things that have already been discussed. I would like to give a somewhat different tilt to the trends that we see underway, however. I see every evidence that the dramatic slowdown in electricity growth that has occurred since the mid-1970s will actually tend to accelerate in the years ahead. It is not because I do not see electric powers being important to the economy; indeed, it is extremely important, and in many senses its importance grows with the advent of electronics and so on. However, in terms of absolute growth in electricity demand, I believe that the evidence is really quite strong at this point that increasingly improved efficiency in a variety of devices that use electricity, in fact, in almost all of those devices, will offset most of the future growth. Indeed, one study has suggested that just in the area of lighting alone we could, over the next couple of

decades, displace a hundred thousand megawatts worth of generating capacity, about equal to the total nuclear supply.

Of course, as Linda Stuntz suggested, the rate of improvement in electric power efficiency is not just an exogenous variable. It will be affected very significantly by trends in public policy, particularly at the State level. Here I also see reason for optimism because what was considered an aggressive energy efficiency program ten years ago would now be considered, I think, quite pathetic. The new move in energy efficiency is to have mandatory State standards for things like appliances, both at the State and Federal level, and for utility commissions to set conditions such that utilities themselves have a great incentive to invest in improved efficiency. This is a very complex area. We don't want to get into the details right now, but suffice to say that in New England, where this concept is being very aggressively developed by several utility companies, there now appears to be a real likelihood that demand growth will fall to near zero and that all of this savings will be done at substantially less than the cost of any new power plant that could be built in New England in these days. Importantly, I think, with this area of efficiency improvement, there is a tremendously high leverage potential, both for the Federal and State Governments, which I think is probably not as true in the nuclear question.

Other factors that are going to have a big impact include some profound structural changes that are going on in the utility industry. The days of a monopolistic, centrally planned utility system where a handful of companies sat down and planned out the direction of the country as a whole are now ending; independent power companies are increasingly playing a major role in determining future supplies. Indeed, the context of some of the remarks here this morning would suggest this is all sort of a central planning discussion; you can imagine the kind of thing that used to go on in the Politburo. The mix of future resources is going to be determined by the market itself, which is involved in an increasingly diverse mix of players. We have recently calculated that if you look at recent, newly-started power plants, that is, ones that have gone under construction, the average size has now fallen to less than 50 megawatts which indicates the fact that they are dominated by cogeneration, renewable energy sources, and so on, the kinds of things that are found more cost effective in the competitive power sector.

In terms of the question of reviving the nuclear power industry and looking towards meeting some of the needs that are being projected in Florida and other places over the next ten and twenty years, I think the first point to keep in mind, in terms of current technologies—and I think this does have a bearing even on efforts to standardize and somewhat streamline these technologies—today's nuclear powerplants have become grossly uneconomical. To interest utilities in them, you are going to have to not only improve their reliability, but very, very dramatically cut their costs. I would agree with Mr. Taylor that there certainly should be some potential to have improvements in this area, but the vast scale of the improvements needed and the very high degree of standardization and sheer numbers of plants that would have to be ordered to achieve that potential I think is a rather daunting prospect.

I, in effect, agree with what Linda Stuntz has suggested which is that during this next ten to twenty years, we will be doing very well to keep nuclear capacity at its current level. Indeed, it is almost certain to decline during this period. There will be no significant addition to nuclear capacity this decade, and I've calculated that we'll have to order something like twenty plants in the following decade in order to just replace those that will be retired early. This, I believe, is in itself a very difficult goal and certainly doesn't hold out the prospect that nuclear power during this immediate planning horizon is going to play much of a role in solving problems of any kind.

In terms of the longer term question of reviving the nuclear industry up to the year 2030 and beyond as DOE is now considering, you get, of course, to the question of the advanced reactor designs of the type that Mr. Taylor has already discussed here. I think the important thing to keep in mind with these new technologies is the enormous amount of uncertainty that surrounds them. And we're really talking about things that are very fundamentally new and untried. The experience in the nuclear industry would certainly suggest that it is hard to predict reliability, let alone cost effectiveness of technologies, when you are just looking at paper studies. Indeed, I believe that these technologies have in many senses now been over sold by the industry in terms of the likelihood of their moving forward in any kind of significant pace.

If you add up the lead times involved in design work, in terms of building a prototype, testing a prototype, beginning to build a commercial reactor, I think you can say that even under optimistic conditions, it is going to be 30–35 years before we begin to see a substantial amount of new design technologies, say fifty plants in operation. Interestingly, if it is going to take that long at a minimum, that is about the time frame when we are going to see the massive shutdown of virtually all of the nuclear plants that do exist today. And so, again we are talking about an option basically for replacing existing technology and, I believe, a very problematic option at best.

Let me conclude by suggesting a little bit about what the role of the Federal Government and the Congress might be in all of this. The Federal Government's role in the whole question of where the utility industry is going in this country is, and I believe should continue to be, limited in the years ahead. The U.S. Government did not decide to end nuclear orders in the mid 1970s, and I believe the Federal Government will not make the decision as to whether it will move forward in the future. Rather, there are a variety of factors that involve the economics of the utility industry itself—its structure, the attitudes of the general public, political conditions, the situation with nuclear waste, and so on—that will be the determining factors. The role of the Federal Government is really one of operating at the margins, and I believe that it makes a lot of sense to have structured these hearings the way you have because I believe that the issues being discussed today will be much more fundamental in determining the direction of nuclear power than are the regulatory questions that you will discuss later on. The trend away from nuclear power is profound enough that twiddling with the regulatory mechanisms is not going to have a big impact. I do

believe, however, that there is a rather serious risk at this point of the Federal Government's being dragged into a multibillion dollar, unsuccessful program to develop some of these new reactor designs. Certainly, the history of DOE management of large nuclear projects in the 1970s would indicate that at minimum a red caution flag should be up as you consider these programs. Also, of course, consider the fact that DOE currently spends a disproportionate share of its resources on the so-called nuclear option.

Finally, I believe that it is almost certainly true that the leverage of the Federal Government, its potential to do more to provide cost-effective, environmentally beneficial solutions to the country's power needs is much greater in a number of other areas than it is in nuclear power. There is a great deal that the Federal Government could be doing to promote energy efficiency, to promote decentralized renewable energy sources, and to promote a variety of other options that it is not doing. I would certainly suggest that while that is clearly the subject of another set of hearings, that is what deserves emphasis, as is the issue, as Senator Reid quite rightly points out, of addressing currently existing nuclear problems first—of waste disposal and so on.

Thank you very much.

Senator GRAHAM. Thank you very much, Mr. Flavin.

I'd like to start with one of the questions or concepts that was raised by Mr. Flavin and that is what is the Federal Government's role, and I'd like to suggest an answer to that question for purposes of eliciting comment. It goes back to the statement that Mr. Wilson made that he wants to have the maximum number of options from which to choose to meet the need, whatever that need is projected to be. I will start by defining the role of the Federal Government as an attempt to do so by using public policy to create a level playing field with issues such as environment and safety so that from that playing field, then the market place will operate to determine which technology is the most appropriate. I would be interested in your comment of that definition as what the role of the Federal Government should be.

Ms. STUNTZ. Senator, I agree with that. I think one theory where Mr. Flavin and I agree the market will determine and should be determinate of what technologies are used and indeed of where that line ultimately gets drawn between efficiency and its supply, whether its coal, gas, or whatever. But the Federal Government has got to make sure, as Mr. Wilson said, the option is available; that it has not imposed burdens that disadvantage that technology which is other technologies that make it virtually impossible for that option to be available. I think that is whether it is technological or regulatory, that is really what the Department of Energy is trying to do.

I've got a couple of other comments on things Mr. Flavin said that I think are kind of fundamental, but I'll wait, it is not directly related to your question.

Mr. WILSON. I think your point is well taken, and I think the center of my remarks was to try to remove, I don't know whether you would call them artificial barriers through consideration of power, so that you can consider it on the merits, the economics. That presumes I think though that other energy sources in the

market are appropriately priced such that the price actually reflects both economic and societal costs of making that generation option, be it coal, oil, gas, or nuclear, whatever you are talking about; remove those barriers so that in fact you can make a determination on the merit of choice. I think that would be the best.

Mr. TAYLOR. You're right. I agree strongly that it is a fundamental role of the Government to provide that level playing field, particularly in assuring a common approach to our environmental and public health needs, and fostering very careful and quantitative assessments of the impact on the environment of the various energy alternates as well as their impact on public health, something we don't really have in full perspective at this time.

I would suggest the Government has an additional role which has been fairly traditional and although difficult to carry out, as Mr. Flavin has pointed out to us, that is, to foster energy technology development which is not within the private sectors' ground rules for financing. The very long-range programs such as the liquid metal, and gas-cooled programs are such that you cannot justify a private investment because of the long time frame for its eventual fruition. Here, if that development is to occur, the Government will have to play a role in pursuing it. That need is not so strong in the advanced light water program because it is an existing industry; in our judgment new water-cooled systems can be brought into play in a time frame where private sector investment can be justified if the barriers that Mr. Wilson pointed out can be removed.

Mr. FLAVIN. I, too, agree with the concept of a level playing field, certainly. And indeed, one of the things that we are just beginning to solve in this country is the tilt of the playing field which has been generally tilted in favor of nuclear power throughout the post-war period whether you are looking at Federal budgetary expenditures or whatever the measure is, that's been the tendency. I believe that we are now on the verge of a much healthier situation where we do have a more level playing field. I think the more we move in that direction, the better off we will be. However, the Federal Government will of course need to, in many ways, give unique attention to some aspects of nuclear power. The whole regulatory framework of the NRC is geared to the fact that nuclear power is a uniquely dangerous technology and certainly no one would argue that those kinds of constraints need to be removed. Certainly they can be streamlined somewhat. But again, I don't think that really gets at the fundamental problems of this industry.

Senator GRAHAM. Mr. Flavin suggested that the goal of the Federal Government acting to create a level playing field by focusing its attention on issues such as safety and environment and then letting the market place decide which choice is the most appropriate has, in fact, not been adhered to and that there has been a tilt toward nuclear with Federal policy. I would be interested in the comments of the other members of the panel as to whether you feel that the Federal policy has been preferencing one technology over the other, and if so in what areas.

Mr. GENT. I think we have to be careful to distinguish between the short-term and the long-term research and what is happening today in the operating systems. I think the Federal policy today

clearly is in favor of independent power producers and it is the way every electric utility is being asked to proceed, at least for the next five years if not the next ten years. On the subject of what the Federal Government's role should be——

Senator GRAHAM. By favoring independent power producers, is that favoring a particular technology?

Mr. GENT. Generally, combustion turbines, sometimes combustion turbines coupled with a supplementary fired boiler, characterized generally by using natural gas, short lead time installation, commit at the last minute.

I think what needs to be emphasized is the wisdom of Mr. Wilson's remarks about the need for certainty in siting process. This is a State process, and this is still the United States, so we have a lot of attention that needs to be given to how the States accomplish their processes of siting. I think that is where the big logjam in building any kind of new capacity is going to come.

Mr. WILSON. I have just a comment on that, and Senator Graham, I know that you are quite familiar with the situation in Florida. You participated, I am sure, in the Powerplant Siting Act. It has very strict time limits on consideration, both by the Public Service Commission which makes the determination of the need for construction of additional capacity or transmission line capacity, we have 90 days to consider and make that decision, and then that goes on to the Governor and Cabinet; from that point to the Department of Environmental Regulation which also has a very strict time limit within which to make that decision. I think that is the kind of certainty that needs to enter into this process so that people who do planning and prediction not feel that it may take five years to wander through the process to finally get both construction and operating licenses for nuclear plants. That tends to level bias in decision making process so that you can make rational decisions among generation technologies.

Senator GRAHAM. To what degree is that issue of certainty a function of the reliability of projection of future needs and the fact that there is likely to be a relationship between the time period of projections, i.e. we can project with more accuracy needs in 1995 than we can in the year 2025, and the length of time between the determination to initiate action and when action will be completed?

Mr. WILSON. There is clearly a relationship, and we've seen the consequences of long lead times on nuclear construction where demand has in fact fallen below the projected level, and in certain States that has caused reconsideration of the need for powerplants; powerplants have been cancelled in mid-construction. Fortunately, or unfortunately, in Florida that's never been a problem with the rate of growth we have because whatever demand growth we've projected has generally been, if not right on the money, then it certainly catches up within a couple of years. In other parts of the country that has been a very serious problem. It can be exacerbated by very lengthy either construction licensing or operating licensing processes. We all know after Three Mile Island, the NRC required the re-engineering of a number of aspects of plans that were currently under construction and retrofit of the operating plants. This had a tremendous effect on both the cost and the length of

construction time of these plants. The longer the construction time the higher the cost.

In Florida, we have generally, once we determine the need for a plant, have treated that more or less as a commitment that once that plant is constructed that it will go into rate base and be termed as being a prudent investment by the utility. That doesn't avoid the examination of imprudent amounts of money that are being spent, but we would look at a nuclear plant the same way that we would a coal plant, and if there are imprudent expenditures those would be the subject of scrutiny by the Commission.

Mr. TAYLOR. Senator, the problem of demand projection over a lengthy period of time is a serious one and would represent, if we were faced with a ten year construction time for a nuclear power plant, which we know has been recent experience, a substantial barrier that is independent of any Federal regulatory or related restriction. So our program has been established to set a goal that these reactors will get built, construction will start and be completed in a four-year timeframe. This was done in the late 1960s and early 1970s for plants of about 600 megawatts electric in size, and I believe it can be done again if we include the simplifications that we've talked about; if we establish, and this requirement document demands that, that the drawings of this plant will be close to 85 percent complete before anybody turns a shovel so that the time frame during which the vast amounts of money will be spent on the plant would be restricted to that four-year timeframe. That kind of projection period is reasonable from the viewpoint of a private sector investment.

Senator GRAHAM. Mr. Flavin suggested that there were some factors that are beyond Government policy which are causing a decline in nuclear power and its potential as part of our future. Among other things, he mentioned structural changes within the energy industry. I wonder if you could comment on those observations and whether you agree or where you might have a contrasting opinion.

Mr. TAYLOR. I'd be glad to comment on this remark. To me the most fundamental non-Governmental market-place issue, Linda Stuntz pointed out with her curve which showed the radical shift from 7 percent annual electric growths down to less than 1 percent, 1.5 percent at the best. In that time frame, where the 7 percent was not only there but was projected to continue, a vast effort was made to increase generation capacity. When it was realized that the change to a much lower demand growth had occurred, many plants were cancelled, but there was still a build-up of tremendous excess capacity. So there has been no reason to order any baseload generation now for the better part of a decade, here or around the world because the same economic conditions have been seen around the world. That is a plateau that exists because of the lack of need for additional generation capacity. We see that disappearing. We see for sure that it will occur toward the end of this present decade, which suggests we need to plan now to expand our baseload generation capacity.

Ms. STUNTZ. If I could comment on that as well. I agree with that. I think there are three things that differentiate Mr. Flavin and I today. First, and I want to underline what Mr. Taylor just

commented on, the demand trend most recently, since 1986, the electricity growth in 1986–1989 has been about 3 percent a year. Now, we don't know that this will continue. Not very many people expect that amount of demand growth, but clearly I think it marks the end of perhaps the demand lag built in after the oil price spikes of the 1970s, and the time is coming when new baseload capacity will be needed.

Mr. Flavin's point that the entire world is turning away from nuclear is, I believe, very much overstated. If you look, for example, at NEDE's most recent released long-term energy plan in which they project dramatic increases in nuclear power, that is in part because of concern for greenhouse gas emissions, but I would submit to you that NEDE and Japan are not the only people that are doing that. Also in part because they are experiencing substantial electricity demand increases; they cannot count on competing that with oil or with anything else. So they are turning to nuclear, and I think they are not unique in that position. Sweden is reconsidering what it can do since it is interested in stabilizing greenhouse gas emission; it has said it will not have new hydropower and it will not have coal; that doesn't leave very much else if you're going to have any growth at all. So I think it is an overstatement to say the entire world is turning away from nuclear.

Finally on the operating cost point, there are a lot of different numbers out there. Clearly economics are an important issue and I think it is hard to understand. One of the things we need to do is compare apples to apples. Mr. Flavin's written testimony does a lot of comparing of new renewable gas and other technologies with old nuclear technologies. I don't think that is fair or necessarily useful. There are lots of different ways of looking at operating costs, but what the Energy Information Administration does is look at weighted production expenses, output weighted production expenses; and in 1987, for example, the most recent year for which we have complete data, for 259 coal-fired power plants, they average 21 mills/kilowatt hour. For the same period the production expenses for 63 nuclear plants also averaged 21 mills/kilowatt hour. Again that is not capital cost, just operating cost. But, by at least one measure there is really no huge disadvantage economically in operating cost of nuclear power plants. So I think, again, you have to look carefully at what the derivation of those numbers are.

Finally, I'd like to respond to something Mr. Gent said and I guess I disagree that there is a Federal policy in favor of independent power producers. I think there have been a lot of independent power plants coming on line; in fact, probably half of the generation coming on line this year will be independent power generation. I think it is as much a State policy function as a Federal policy function. Basically it reflects something you put your finger on which is avoidance of risk. You can't get, or are concerned, States—perhaps not like Florida which has not second-guessed utility decisions—to invest in large plants, overshot demand; you're not going to take that risk again, you're not going to subject the shareholders to that risk. And if you can get somebody else to build a plant to do that, that is what you do. So I don't think it is quite fair to say that we're having a lot of independent power producers because of Federal policy. I think Federal policy should be even-

handed in that regard. There's obviously room for both in the market-place and I think we need both.

Mr. WILSON. I think, Senator, there are a number of comments about independent power production. There are a number of factors that lead to that inference today. They are the result of experience over the last ten years where utilities have been burned by building large generation power plants and not being allowed to recover full cost of those when they come to the rate case, plants being cancelled; there has been different treatment of that, some to the detriment of stockholders. It is tough. Wall Street is very reluctant to back those kinds of decisions by utilities because they have been burned.

Independent power production is purchased power that most States pass through dollar-to-dollar straight through to the rate payers. There is very little risk for a utility or an independent power producer because they are literally assured of 100 percent recovery of their costs by the price of electricity they are paid. It is a little bit of an artificial situation, but in fact I think that is one of the very strong factors that lead some utilities in this country in some States to favor independent power production.

Senator GRAHAM. Do you see independent power producers becoming a more significant part of nuclear generation?

Mr. WILSON. I heard a scenario described by someone at a conference during the Spring that he thought the most likely scenario for a new power plan would be an independent power produced where the vendor—a Westinghouse, a GE—would take a stake in a plant, an architect engineer may take a stake in a plant, and the money would be raised to build and construct the plant and then its relationship to the utility would be as an independent power producer. I'm not quite sure frankly how likely that is. There would be a lot of concern about controls that are generally exercised over nuclear power plants, both by the NRC and others, that would have to be addressed. I don't know whether that scenario is very likely. It would be one way that, quite frankly, parties would be able to protect themselves from the kinds of decisions that some State officials have made with respect to nuclear power plants. If the price of that power or the pass through purchase of that power were done as it is with others, you would then be assured—if you're paid at what it cost, very often what is paid to nuclear generators of independent power producers—because if you're getting it for what it costs and you can make money doing that, then you are not subject to disallowance or whatever. Simply make that amount and you operate with that as your price.

Senator GRAHAM. Let me say I want to encourage you to comment on each other's comments. The purpose of having this format is to get the maximum degree of cross fertilization of ideas.

Mr. Flavin.

Mr. FLAVIN. I do think that this question of whether independents are interested in nuclear power is an interesting point because I do believe that if nuclear is going to have a future, that is almost certainly going to have to be the roots, since that would appear to be the direction the industry as a whole is moving in. The question of course is whether from the point of view of the private investor, whether an investor will risk his own capital in this enterprise,

whether it appears to be a safe and cost-effective investment. Right now, I think you could make the case just based on what the market is yielding that nuclear power is not being found attractive in that equation. Indeed, there is nothing that says that these independent projects have to be the rather small-scale technologies that have dominated the market. If larger plants prove to be economically competitive and to be capable of meeting the demand needs that are required in the future, they can compete.

But I think the extraordinary thing that we have seen develop in the last 5–10 years is that these decentralized small-scale cogeneration, wind, solar, biomass, and so on, have come down in cost rather dramatically and are competing effectively with any known form of new baseload capacity. But that competitive environment, I believe, is the one that will determine the answer to these questions. I see no reason to argue that we need to get back into a sort of an era of central planning, risking rate payers' money on uncertain options, when we know that we have a functioning market place. If public service commissions wish to encourage less use of fossil fuels, if they wish to encourage more efficiency, if they wish to encourage greater rates of construction of generating technologies, there are a whole range of regulatory incentives that can be put in place. And in a number of States, they have, overnight almost, turned around the future supply options at particular utilities.

So I think it really is to some extent in the hands of the public utility commissions, but they should do it not by trying to centrally plan things but by using the regulatory incentives that they have access to.

Senator GRAHAM. Mr. Taylor, did you have something?

Mr. TAYLOR. Yes, I might comment that the issue as we see it is not that nuclear power shouldn't compete in the market place, but that certain rather arbitrary barriers prevent that movement toward competition. My belief is that if those are removed, there will be investors, whether they be IPP or utilities, who will be willing to move ahead again. What we shouldn't forget, I'm reminded by Senator Simpson's comment—there is no course of action that does not entail risk—that in depending upon smaller units which primarily in turn depend upon our gas or oil as fuel, we are taking a risk that we'll move in a period later on in this decade where the availability of such fuel will be limited and the price will suddenly go way up. That is a risk to our consumers as well as to our rate payers. The great merit of a nuclear baseload plant is once you've built it and once you've made that investment, it is one of the systems that is least dependent upon fuel price fluctuations because of the availability of the nuclear fuel and the very long timeframes over which you procure and use that fuel.

Mr. WILSON. Just one comment about the Politburo mode of thinking on central planning of electric utilities. In fact, in terms of engineering, you have to have central planning of electric utility systems. Somebody has to control the balance of generation and load. In fact, you do have to have central planning. Now you may have various sources of generation, but at some point that has to come together with a central plan to know what you've got, what you need, and what is going to be paid for. So that element of cen-

tral planning can never be eliminated. If you ever get to the point where you've got an "energyomatic" at your home where you dump your garbage in and get energy, maybe you can avoid that situation, but I don't see that on the horizon.

Senator GRAHAM. If this is not a contradiction of terms, don't you think it can be characterized as decentralized central planning; decentralized first and then most of it is done in the 50 States rather than at the national level, and then within the 50 States, it is a combination of a State regulatory agency which is assuring that the licensed franchisees will fulfill their obligation of providing reliable service to their customers and that those franchisees will receive compensation appropriate to their efforts to accomplish that. So you would have centralized planning in a decentralized mode in terms of politically and economic decision-making.

Mr. WILSON. Yes, sir, and you have cross-State planning as well as regional planning. We buy a substantial amount of power from The Southern Company out of Georgia and there are a number of power pools around the country that have to coordinate their power needs. The point I was making is that from an engineering standpoint somebody has to control, there has to be a certain amount of central control of your load with your generation, and at any given point, somebody has to control those interflows.

Mr. GENT. The economics in the situation dictate that we operate in an interconnected manner, that one electric utility is interconnected with another, as the utilities in Florida are connected with The Southern Company, and so on. We have 4 interconnections in North America; we have the Province of Quebec which operates all by itself because it has some unusual reliability characteristics, and then we have Eastern interconnection which is everything excluding Texas east of the Rockies, then we have Texas which operates as its own interconnection, and then the Western systems. So, if a disturbance occurs in Florida it can be detected in Minnesota. That is not only a bad thing, it is a good thing at the same time. So electric utilities have to operate together and to that extent, I second what you say, it has to planned. There have to be rules and people have to abide by the rules.

Mr. FLAVIN. I don't think anything I said contradicts that. The industry as a whole, obviously, does have to have some degree of planning, and transmission and distribution, and in particular, needs to be coordinated on a large scale. But that is not to say that we have to have a monopoly in the construction of power plants. The way a market economy operates is via contractual relationships between individuals and companies. And the way the electric utility industry is increasingly beginning to operate on the generation side, independent companies sign contracts to build plants and sell the power at agreed prices. It is within the power of the utility company to make those agreements and go out and look for the best deal they can find and indeed the independent power generator has a great deal of money to lose if they do not come through on their contracts. Again, I just don't see any need to go back to the more centrally planned situation that existed in the past when we have this much more diverse, decentralized, more competitive industry that is now taking shape.

Senator GRAHAM. Let me ask Mr. Flavin, and anyone who would like to comment, are there some long-term economic costs that are going to be paid for the move toward smaller scale operations? That is to say, Mr. Wilson said price that a utility is allowed to pay for an independently produced power is their highest unit of cost, the cost avoidance rate of which—for instance, for a typical utility, what would the avoided cost rate be as compared to their average cost?

Mr. WILSON. It would change from day to day, but——

Senator GRAHAM. Would it be 10 percent higher, 20 percent higher?

Mr. WILSON. I couldn't give you an exact figure, I'm sorry. Someone else may be able to do that.

Senator GRAHAM. The question I have is key. Are we on a track which is encouraging smaller-scale more peaking power, as opposed to baseload power which, over time, is going to raise the average cost of energy in this Nation?

Mr. FLAVIN. I believe just the reverse, Senator. Increasingly, public utility commissions are actually going out for competitive bids. They are no longer tied to avoided cost that go up to this very high level. That was the concept that was first tried in the 1970s. I think everyone agrees that it produced more costly independent projects, particularly in California, than it should have. And the California Commission, along with many others around the country, are now in the process of implementing a variety of competitive bidding systems so that in fact we will get the least expensive form of power that is available. Again, nuclear is free to compete, coal is free to compete; we don't necessarily have to be relying on the independent technologies that we rely on largely today.

In terms of potential dangers, and there clearly are a number, I think most of these can be avoided through prudent incentive based regulation. Probably the one that stands out in my mind is the potential for excess reliance on natural gas, which of course could go up steeply in price in the future. But again, I believe there are incentives that can be put into the competitive bidding system that will insure that natural gas-based sources do not become the predominant source of independent power supply. That is one of the many choices that are before public utility commissions.

Ms. STUNTZ. If I could respond. You're asking a serious question, one that disturbed the Secretary, I can tell you, and he's got us at work, is this question is there a trade-off between large powerplants and small powerplants, how the economies of scale, do they still exist; that was one of the reasons we had for central powerplant structures. I think there are two different things that have been driving us toward smaller plants. One is, as Mr. Taylor correctly said, in many areas of the country we still don't and previously did not need new baseload generated capacity. So to the extent that we are getting small plants or peaking plants because they aren't needed, then that makes sense. To the extent, however, people are not building bigger plants because in fact the risks are such that if you over-estimate your demand just a little bit, you are going to get penalized, and so it is a lot easier to build in small increments; and you simply cannot afford the regulatory risk or get financing in the market for a much bigger plant, then we may in

fact over the long term be doing something that is not efficient as a Nation in terms of our power supplies.

There is a lot of literature out there, a lot of conflicting views about whether economies of scale still do exist. I could, and certainly Mr. Wilson could, tell you there are a lot of utility executives who still believe that big power plants, whether they are coal plants or nuclear plants, do have economies of scale, they are per unit cheaper, better for society, it is easier to control pollution in one place than it is from a lot of different sources. On the other hand there are those who say by the time you factor in the cost of financing, the uncertainties for the longer plant life, longer construction time involved, the economies of scale aren't so clear. I think it is very important to keep it [illegible] and as we see the need developing for new baseload capacity, it [illegible] mething we're looking at very carefully to make sure we're not perhaps over-emphasizing the short-term costs to the disadvantage of longer-term benefits. It is a tough issue.

Mr. GENT. I'd like to accentuate the difference in cost between building a large plant and a small plant. My view is almost entirely due to what you think the price of natural gas is going to be. I know also that the Department of Energy has struggled with their predictions of both the availability and deliverability of this fuel. If the price of natural gas suddenly skyrockets, then you can expect the price of oil to start to go up, then oil and gas-fired electricity units will cost a lot more than a coal-fired unit. If you believe it is going to stay where they predict it is going to stay, then you should build a gas-fired unit.

Mr. WILSON. There is a statute in Florida that we operate under when we do determinations of need for construction of additional capacity that requires the utility to present and the Commission to consider whether the proposal for construction of capacity is the least cost way to meet that need, which would include consideration of conservation measures, alternative energy sources. Recently, we have had utilities go out for bid or request for proposal for construction of plants to meet that capacity need. Tampa Electric Company has recently had one approved which FERC has recently disapproved for some bizarre reason; Florida Power and Light is in the process now of evaluating a request for a proposal for revision of additional capacity as well. We look not only at conservation load management, alternative energy sources, utility constructed power, as well as independent power. We have to make the determination of which one is the most cost-effective way to go to meet any given capacity need when someone is petitioning for the right to build. We have to go through there, and, of course, a lot of it depends on fuel, future fuel costs estimates which are extremely unreliable.

Senator GRAHAM. Coming back to the question of planning, centralized versus decentralized. It has been suggested that there may be a need for an increasing degree of national involvement in energy planning, particularly as we relate to some of the issues of international environmental concerns, potential for an international treaty on greenhouse effects, and the concern of the increasing reliance of the United States on foreign energy sources. What are your thoughts on the need for an increasing national role, and, if

so, what form should that national role take, including what agency should be given that responsibility?

Mr. WILSON. If I can take the opportunity to sort of toot DOE's horn for a moment. I think the idea they are pursuing with the National Energy Strategy document with the process they intend to send to the President is a good idea because it is going to—I hope this is going to happen—it is going to force the reconciliation of a number of different positions on what a national energy policy ought to be and look at a series of options that will require a party either advocating a position or evaluating that, if you take away one energy source, you're going to have to reconcile that with adding another energy source. If you strike one from the menu, you've got to replace it with something else because if you look at the total energy needs of the country, we need to have a strategy to meet that demand. If you just say we're not going to have any more coal, you've also got to address at the same time what is going to take its place. If we're not going to have any more nuclear, what is then going to take its place.

A number of State commissioners I know have been talking for years about we call the lack of an energy strategy. In fact we sort of have a de facto national energy strategy, but it is the result of a number of very different small decisions that are made and I don't believe it's ever been reconciled into a whole so that you look at every aspect of the energy situation in the United States and make some decisions about what we ought to be doing. In fact, if you look at what's been happening, our dependence on oil has in fact increased substantially and I don't know that there was ever a conscious decision that ought to be the energy strategy of the United States, but it is in fact what is occurring. I think if you bring all disparate factors together in one place at one time and can make those kinds of decisions, it would help everybody in the country.

Senator GRAHAM. Ms. Stuntz, what does the Department of Energy feel its role, beyond what it is currently doing, might be in terms of providing some greater strategic direction in energy policy.

Ms. STUNTZ. I appreciate Mr. Wilson's comments, and I think he captured very well what it is we are trying to do. We cannot, and particularly in a country with our federalist heritage and the decentralized systems we've had for a long time, we're not under any illusions that we can suddenly dictate from Washington what kinds of energy people should use and when.

We think it is critically important for some of the environmental reasons you talked about—Clean Air Act, climate change, all these things are out there—we can have no strategy and simply respond in the way those things force us, but the results of that would really be catastrophic. I'm reminded recently that Rhode Island has taken a position as I understand it that they will no longer allow any coal-fired electricity plants, hydro-electric, nuclear, or oil. So that doesn't leave very much. Now they can import hydro-electric power from Canada, and that is in fact something that we expect will increase particularly for the Northeast, but at some point, we need to recognize that there are limitations on our ability to conserve. We can do better, Mr. Flavin and I agree on that, and I think we are fairly aggressive in our projections, but I think we

need to do a better job of educating people than we have done about what the choices really are so that when the decision-makers involved in those various levels of making those decisions make them, they will know what the consequences are and be prepared to live with them. I think if we can accomplish that, if we can just get the information out there to show people that if you are in fact going to rely heavily upon natural gas, we don't get nuclear plant life extensions, are you really prepared to see nuclear drop off the chart after 2010 with no new plants, if coal can't replace it, as Mr. Wilson said, because of the Clean Air Act or other constraints, then what is going to replace it; and are you prepared with the anti-competitive effects that they have, not to mention consumer affordability as a Nation, if other nations don't do the same thing.

I think your question also had an important element about the need to keep an eye on what others are doing. China and India, for example, have vast reserves of coal. If we were to unilaterally decide that we are going to put a moratorium on coal plants while they proceeded to utilize those resources, we would be inflicting a terrific hole in our own foot, and not doing the environment any good because these problems, whether they are environmental or technical, are increasingly global problems. We have to be sensitive to that. Again, I think that is an appropriate role for the Federal Government to play. It is the key reason why the National Energy Strategy is so important to us and to the Secretary and why we've been working so hard on it.

Mr. TAYLOR. The comment that the Federal Government has a very strong policy on environmental protection is very appropriate with no great argument. The fundamental purpose in much of the EPRI work is to provide energy that will meet those more stringent requirements in an effective way. It seems to me fully appropriate then that the Government should have to have a policy to assure adequate energy supply for the Nation, for its economy, for its people. If we fall down in that respect, there will be serious international consequences in economic competitiveness in this country. The availability of electricity in this country is a fundamental to our improvement in productivity, all of which shows itself in the goods which we can export in an effective manner to achieve an effective trade balance.

Furthermore, there is no question that with time there will be more and more protocols on global environmental measures, such as the greenhouse effect, which would put the U.S. in the position of having to provide its energy in keeping with these protocols, as the biggest of all producers of energy in the world. Some of the protocols on global warming have already suggested that together the world should agree to reduce the CO_2 emissions globally by about 5 billion tons per year. Nuclear power today, the 17 percent generated around the globe, is not sending up some two billion tons of CO_2 that otherwise would go into the atmosphere. The combination, therefore, of a policy for careful, effective, and stringent environmental protection with careful, effective provision for energy to meet the economic needs of our country, and the development of effective protocols on environment across the world would suggest a more active Government role in energy supply, and I would agree

with Linda and Mike that the National Energy Strategy potentially is a vehicle for that.

Mr. FLAVIN. I certainly agree that the U.S. Government does have an important new role to play and particularly with the coming era I believe of energy policies that are structured around goals to gradually reduce carbon dioxide emissions, which is I believe likely to be the result of a treaty process that is now under way. Clearly, we need a rethinking of what our national energy strategy is and indeed we do not have much of a strategy in place today. That strategy cannot be one of micro-managing individual technologies, though. That is just not going to work. Rather, it has to be an approach that puts particular incentives in place but ultimately leaves it to the market to determine what the actual technological solutions are going to be.

The overwhelming evidence so far suggests that energy efficiency is going to be the only cost-effective way to get rapid reductions in emissions over the next ten to twenty years. I don't think anything that's been said on this panel today would suggest that nuclear power has any hope over that period of getting significant net additional reductions in U.S. emissions of carbon dioxide. That simply is not possible at this point. In looking to the sort of strategy that we might put in place hopefully this fall when DOE completes its report, is the model that is being followed by about a half dozen of our European allies who have now put in place national goals, the goals are different in terms of the actual numbers, but to limit in some way the output of carbon dioxide. I think it is rather notable that most of these plans rely very heavily on things like efficiency improvements and not one of these countries is proposing to build any significant number of nuclear powerplants in the next 20 years. So I think the guide is there; I think we know the kind of strategy that needs to be put in place; it has to include important general goals and incentives, but it certainly should not go back to try and micro-manage technologies.

Mr. TAYLOR. I'd like to comment on one of those countries. Sweden, as you know, has a legal moratorium on nuclear power which foresees the decommissioning of all their nuclear power facilities. They have set goals, as Mr. Flavin has pointed out, on CO_2 emissions that are causing a total reexamination of the time scale of planned reduction in nuclear power capability in Sweden. I see myself no other answer than that they will decide to continue to operate those plants, and with continued good experience, which we all hope will be the case, may well reexamine totally the whole idea of the moratorium.

Mr. FLAVIN. I think public opinion runs very strongly against that in Sweden. I've talked with some fairly high government officials in Sweden who believe in fact that the letter of law on phasing out that nuclear program will in fact be fulfilled.

Senator GRAHAM. In this decentralized decision-making process we have, someone referred to the fact that we have a national energy policy de facto although not one that has been deductively derived at. One of my favorite quotations is Harvey Cox, the theologian, who says "not to decide is to decide." I think that may be the process by which we have come to a national energy policy. One of the sub-issues under that is the question of predictability and the

degree to which its existence or non-existence drives decisions, drives them toward short-run rather than long-run consequences.

What could the Federal Government do to increase the predictability of the outcome of decisions, whichever decision is in fact elected, and I might give an example. I think a principle in the Clean Air Act is the principle of internalization of cost. We know there has been a real cost to society of the level of sulphur dioxide emissions that we have tolerated over the last several decades. The Clean Air Act is going to try to bring those costs more into the economics of those elements of our economy which generate sulphur dioxide. I think that is a statement of policy which should give some greater degree of predictability as to how those external factors are going to be handled. What are other ways in which the national Government could give some greater predictability to future energy costs and therefore enhance the quality of decision-making as to how to meet future energy needs?

Mr. TAYLOR. A very specific one we have already addressed, Senator Graham, and that is the predictability of being able to operate a plant once you've constructed it, assuming you constructed it as you promised. The Nuclear Regulatory Commission has taken a major step towards a standardization policy to provide for a combined operating and licensing permit but there is still concern among the utilities as to whether that policy would hold forth without supporting legislation. That is a very specific area the Federal Government, I think, could help to remove a barrier.

Mr. WILSON. That issue is one that affects the financing of the plant. Wall Street, I'm sure, their attitude would be that if we don't know that once you've spent these however many millions of dollars on this plant that you're ever going to be even able to operate it and get some return on that investment, we're not going to loan you the money. And that is the source of money for a utility to construct that kind of project. I think there ought to be some predictability in that process. The process should be open, every party ought to have an opportunity to have some effect and input on that decision, but there needs to be a point at which a decision is made that gives both the utility, State regulatory commissions, and the financiers of the projects some firm idea of exactly what the consequences would be and the time frame within which this would happen.

Mr. FLAVIN. I think that probably the main area in terms of overall electricity policy where the Federal Government could play a very useful role would be to formally endorse and very strongly support the movement towards least cost or integrated resource planning that is developing in many parts of the country. There certainly have been some positive statements, but there has also been a bit of ambivalence in terms of Federal support of this area. And I believe that both DOE working independently and perhaps encouraging the Federal Energy Regulatory Commission to be supportive as well, we could find much of the country moving in the direction that New England already has with large-scale utility investments in improved efficiency. And certainly, if you are actually making those efficiency improvements, if somebody is actually going out there finding the right investments, contracting with companies to actually make the improvements, that reduces the

uncertainty of demand growth. Those big spreads between what happened in the past and what is possible in the future that was indicated on the curves shown earlier, a lot of that can be reduced by actually having policies in place that assure that a substantial percentage of the cost-effective potential will indeed be realized.

I think that if we end up having a National Energy Strategy that is focused primarily on removing the current disincentives to improved efficiency, and which really focuses the Federal Government on goals of improving U.S. national energy efficiency each year, then we will have a successful strategy.

Senator GRAHAM. What are some of the principle obstacles to promoting full efficiency?

Mr. FLAVIN. The basic problem from the point of view of the utility sector is that utilities have access to relatively low interest capital as well as a lot of very good engineering expertise when they look to building large powerplants. The individual consumer, the individual company owner who's looking at a possibility of improving their energy efficiency does not have access to that capital nor to that information. So they may be foregoing investments that would have a cost of saved electricity of say two cents per kilowatt hour while the utility might be out there considering a new power plant that would cost six or eight cents per kilowatt hour.

As I've indicated earlier, I think the main effort to redress that imbalance has to occur at State level through the kinds of regulatory incentive programs that are being put in place. But again, I think that it would be helpful if DOE were to move away from a sort of ambivalence on this trend and rather to support it wholeheartedly and to indicate that in fact we would like to see the country as a whole moving in that direction. One set of numbers I've put together would suggest that on a nationwide basis we could be seeing utilities investing over $10 billion per year in improved efficiency if we moved in that direction. I think it is probably inevitable that we will eventually get there, but we'd get there a lot faster if DOE were to support the efforts.

Senator GRAHAM. Ms. Stuntz, I wonder if you would comment on what is your assessment of DOE's encouragement and support of those State-based efforts at greater efficiency.

Ms. STUNTZ. We do support them, and I don't know exactly what ambivalence Mr. Flavin is talking about, but we have in the Office of Conservation; Renewable Energies a least cost utility planning program. It is not huge, but it has provided a lot of funding to the States, to NARUC, to public utility commissions, to help I think some of the really worthwhile and interesting experiments that have been going on, and I mean more than experiments but programs that have been going on in different regions of the country. I think that is as it should be because there are very huge differences among the regions of the country in terms of demand growth, the resources, and the cost of electricity to consumers. It varies almost 100 percent across the country; people in the Northwest have about 2.5 cents per kilowatt hour, people in New York and Chicago pay vastly more than that. So it really has to be done on a local level in terms of where the opportunities are, what is the most cost-effective way to get at them, and how can we get local cooperation.

Senator GRAHAM. One of the things that's been in the paper a lot the last few days, including today's paper, is the implementation of a set of education goals that were established between the Governors and the President. Now we're talking about a report card that is going to be annually issued on how the States are doing in meeting these education goals. Has the Department of Energy ever contemplated that doing a report card on how well the States are doing in their energy efficiency efforts as a means of focusing attention on the fact that you consider that to be an important objective and to encourage comparative efforts and transfer of information and strategies from one State to another?

Ms. STUNTZ. I am not aware that we have. I'd like permission to allow the Assistant Secretary for Conservation and Renewables, who runs that program, to respond for the record because there may be activity underway similar to that he knows of and could submit to you. My guess is that we have not—only because these things are still relatively new and, at least with the education goals, you've got the goals clearly in mind in terms of what you want in a particular period of time. I think the States are all in such different places that to be able to grade somebody suggests you know where it is they ought to be going and how quickly they should get there. I don't know that we know enough yet to do that all across the country.

[The information requested follows:]

Senate Committee on Environment and Public Works
Subcommittee on Nuclear Regulation

Insert for the Record
Hearing of August 1, 1990

Q. Has the Department of Energy ever contemplated doing a report card on how well the States are doing in their energy efficiency efforts as a means of focusing attention on the fact that you consider that to be an important objective and to encourage comparative efforts and transfer of information and strategies from one State to another.

A. When the Energy Policy and Conservation Act of 1975 established the State Energy Conservation Program, it provided that each State would aim for a reduction of 5% or more in the amount of energy consumed in that State in 1980. Each State's Annual Plan updates that goal, and they submit Annual Reports on their energy savings achieved under that program. DOE furnishes an annual report to the President and Congress which, as stipulated by the law, includes an estimate of the energy savings achieved by each State, a summary of State accomplishments, and highlights of innovative programs undertaken by individual States.

While this process does indeed focus attention on the importance of energy efficiency objectives and is widely used for information-sharing purposes, there are some drawbacks to the report card approach. It is unlikely that a single standard or set of standards could effectively and equitably measure the worth of all State activities. Although they are informative numbers, neither total energy savings nor percentage demand reduction are, in themselves, accurate indicators of program success. Consumption patterns and the mix of industry, commercial, and individual energy demands have strong influence on the type and amount of energy savings available through demand reduction programs. Regional differences in weather can impact the type of programs and the manner of implementation. Numerous other factors also play a role. The DOE integrated resource planning program recognizes this in that it seeks to develop a menu of approaches for use as appropriate by State regulators and utility planners, rather than a single national guideline or prescription.

DOE does provide information on integrated planning methods and techniques and on results achieved as a result of various programs. This information is made available in reports issued through the National Technical Information Service and in presentations at conferences and professional symposia. It is also disseminated through special analysis and tech transfer mechanisms such as NORDAX, a Northeast regional activity established for this purpose.

Ms. STUNTZ. I had an interesting conversation with a fellow commissioner from Wisconsin at our Energy hearing a week ago on energy pricing and this whole issue of externalities, which I think you have talked about. It was very interesting and I just asked her, I said your commission is, you think, fairly progressive on this; they have a combustion charge they sort of assess and they were among the first in assessing an acid rain-related charge, I said do you think the Federal Government ought to tell the States, the commissions you think are recalcitrant, how they ought to be doing it, whether they should be decoupling utilities sales from revenues? And she said no, I don't think that would be right. It creates the incentives for us to go in the direction we want to go, but don't tell us exactly how to do it. I think that is what we're trying to do. I think that makes a lot of sense.

Senator GRAHAM. I'm not suggesting that we change our Federal system, quite the contrary, but as a former Governor, I can tell you that if people in your State find out that another State is performing similar activities and doing it more efficiently or effectively than you are, that creates a political pressure for you to at least respond as to why you are not doing it as well as someone else. Whereas if you are ignorant of what other people are doing or there is no political process by which that information can be effectively incorporated into the political imperatives of each State, it gets lost. I would just suggest that you might consider how DOE could play a role in that.

Ms. STUNTZ. Your point is well taken.

Mr. TAYLOR. Senator, I might comment that the utilities in fact are sponsoring work to improve the efficiency and conservation of its customers' equipment. The fastest growing program at EPRI is in fact what we call "end use" technologies. I can just give you some examples, they are in the written testimony I submitted on conservation and efficiency related achievements. We, working with Carrier, developed a revolutionary heat pump which has now been commercialized after six years of effort which offers 30 percent more efficiency than current models and is the most environmentally benign of any HVAC technology. We're developing a refrigeration system directly with Safeway, a big grocery chain, using multiple compressors and a variety of control strategies which show efficiency gains of more than 20 percent. And now we are sponsoring nationwide demonstrations of these advance designs. We're developing electronically controlled adjustable speed drives with the potential to reduce the industrial sector's energy requirement by over 15 percent. And of course, we've been very active in developing demand-side planning and implementation methodologies to assist the utilities in controlling and conserving the energy production itself. So utilities are willing to invest money to improve the efficiency of their customers' equipment and systems in the interest of conservation which they recognize as vitally important in the long range.

Senator GRAHAM. Your list of examples of what's happening I think is impressive and raises a question to me. I believe in principle that if you're asking someone else to do something that you should first begin by asking yourself what you are prepared to do. In this case the "yourself" is the Federal Government. How energy

efficient is the Federal Government and how much of a leadership role has it played in stimulating and serving as a role model for other large-scale energy users and producers in this country?

Mr. TAYLOR. Senator, I'm afraid I can't give you a good answer to that. I've not studied that.

Senator GRAHAM. Is this hearing room a role model of efficient use of energy?

[Simultaneous response of no.]

Senator GRAHAM. I wonder, at the Department of Energy, do you do any analysis of the role of which the Federal Government is serving as a model of what a big energy user and producer should be doing?

Ms. STUNTZ. We do administer a Federal Energy Management program—again, I am not as familiar with the details of that program as the Assistant Secretary for Conservation and, Renewables—but it is a mixed story. We have some success stories, but recently, we like the rest of the economy have begun to increase our consumption of energy and there is a lot more that we can do and we're going to do. Under Assistant Secretary Davis' leadership, we have just recently announced, for example, right here in Washington a joint venture with Pepco and some others to do some relighting of Federal buildings.

The big problem, and I'll tell you very honestly, is the capital. And it is a problem that is universal across all these conservation issues. Generally speaking, more efficient technology, whether it is compact fluorescent light bulbs, cost more money up front. If you are willing to wait four years or six years or whatever your planning horizon is, you will in fact save money over the life of that bulb. Generally speaking, the consumer discount rate is different from the social discount rate. Similarly for Federal buildings, energy efficiency improvements take capital, and under the kinds of budget constraints that we have had there really has not been very much money made available for new energy efficiency capital improvements. We have tried to work with things called shared savings contracts, which involve the private sector in furnishing the up-front money, giving them a share of the energy savings over time. There were procurement difficulties with those. There is legislation I think pending now in the Congress that would help solve some of those procurement problems, hopefully make that a more effective vehicle. But it takes a lot of up-front money to install or to retrofit a building.

There are mandatory Federal efficiency building standards now for new buildings, and we hope to encourage the private sector to adopt those as well. But again, particularly in markets like this area or others, it is sometimes not an easy thing to get builders to do it. So it's got a new priority under this Administration and the Assistant Secretary for Conservation and Renewable Energy. We are not where we want it to be yet; we recognize there are difficulties. I think there is legislation also pending aimed particularly at the Defense Department which is the largest consumer of energy in the Federal Government. It just has not been as high a priority as it should have been and as a result when budget decisions were made about where to spend the agency budgets, it did not go to energy efficiency necessarily.

Mr. WILSON. Senator, I would like to make a couple of points. One is the discussion of least cost planning. In fact I think it implies a certain amount of centralized control. In Florida, we have spent literally hundreds of millions of dollars on conservation and least cost planning. The ability to do that was the result of the fact that we have regulated monopoly utility providers and service who can permeate the entire service area and reach every customer with the ability to average cost over that body of customers. That amount of centralized control is certainly a good thing and gives you the ability to do that. We have spent, as I said, hundreds of millions of dollars in conservation and load control, efficient appliance rebates; we contributed $200,000 to $300,000 to the Florida Solar Energy Center for research on variable speed motors to go in air conditioners, which is good technology to spend your money on.

But what we discovered is energy price plays such a central role in the behavior of consumers. As we saw energy prices rise during the 1980s, we saw conservation of energy; as prices fell, we've seen an increased usage of energy. Even with our most effective conservation programs for residential areas, if you are able to install any conservation measures such as insulation and it allows you to reduce your utility bill, there is a rebound effect; the customer who previously had the thermostat set on 75 degrees, because of the savings, in the summer they can run that thermostat down to 72 degrees and achieve a higher comfort level at the same price they had previously. Which is why I don't put a great deal of faith in predictions of what conservation would do in the future and how much energy you can squeeze out of that because it is a function of a lot of things related to consumer behavior.

In Florida we've been doing least cost planning, what is currently popularly called least cost planning, for a number of years. We are currently looking at new programs by utilities to look at demand-side management with the idea that you would make a utility indifferent in terms of its investment decisions as to whether it constructed generation or whether it tried to affect the demand on the customer side of the meter. I think that also speaks for a certain amount of central control. One of the problems we have, I think, in this country is a very short time horizon corporations and businesses take. They want to know what they will earn the next quarter, not where we're going to be in five years. Consequently, when they have a decision they can make on a conservation or efficiency technology, and the payback period is 4–5 years, the interest declines very rapidly. The utility, on the other hand, is in the position to make that kind of investment and it can earn a return on it because their planning horizon can be 5, 10, 15, or 20 years. One of the things we are looking at is having utilities invest in efficiency measures in commercial industrial areas and earn a return on it or share the savings because they are willing and able to make that investment because they have more of an assurance that they are going to get a timely return on their money; whereas the customer who thinks much more short term, the next quarter or next six months, would not make that decision, even though in the long run it would be the best decision to make.

And the last point, I would just say that what I hear here is there is no one single answer. Conservation is not going to provide

or allow us to meet the demands we are going to see in the future. Load management is not, I don't think renewables necessarily are. It is going to be a combination of sources of electricity or efficient end uses of electricity and conservation of electricity. As I said earlier, my interest is in being able to make economic choices to meet those energy needs of consumers in the State of Florida, which is why I would at least like the opportunity to examine nuclear power as one of those options for the future.

Mr. FLAVIN. Let me quickly echo this point on utility efficiency programs. I certainly think it sounds as if Florida is moving in the right direction with some of the new programs that are being thought of now. And indeed there is a movement towards greater investment in efficiency in many utilities around the country. However, I think it is important to see that on a national basis, it is still true that most utility commissions have policies in place that ensure, really, that utilities will actually earn less profits if they invest, even in the most cost-effective, efficiency investments imaginable. And it sounds as if that problem is now being addressed in Florida, as it is being addressed in a number of States around the country.

I think when we look at these kinds of demand projections, as long as we have this set of incentives in place in most States, as we do today, how are we supposed to even know what the cost effective potential is. Clearly anything that is currently being achieved in the market is less than the potential because the system is rigged against efficiency. It is guaranteed to reduce profits. I would argue that if anything, if we correct these incentive problems, that we are going to find a lot more efficiency improvement out there than is even being projected in some of the more optimistic models that are used in this area and may offset virtually all of the projected demand growth in the next decade or two.

Senator GRAHAM. Mr. Taylor, in your statement you made the observation that all of the United States fossil fuel electric generating stations contribute less than 4 percent to man-made gasses which have the potential to cause a global warming effect. Does that indicate that from the perspective of a global environmental issue that there is no particular need to encourage the development of non-emitting electrical generating sources such as nuclear; that this amount that we contribute today is an acceptable minimal level?

Mr. TAYLOR. No sir. If we could assure that the percentage stayed there, I suppose you could put it aside as a worry; but in order to meet the economic growth requirements of our country, and when you then reflect on the even more demanding growth requirements for many countries that are not as affluent as we, you are talking about major increases of CO_2 emissions around the world. So we look on it as not a panic issue; it is not a short term problem that we have to throw everything aside to address, but it is a long-term problem of potentially serious consequences. We don't understand fully those consequences. But there is no way that we see that we will not end up with major increases in emissions around the world.

Studies done at EPRI suggest that if you look at the global energy requirements and you set what we judge to be conservative

ground rules, namely, that there will be a one-percent annual population growth and a 2 percent global GNP growth, we will need four times more energy by the middle of the next century than we are generating in this world today. This means that man-made CO_2 emissions will be much more important in the future and you can't wait until it happens; you've got to start addressing it at this time.

Senator GRAHAM. Ladies and gentlemen, I want to say how much I appreciate your sharing your thoughts with us today. This has been a wonderful seminar for a person who is trying to acquire a basic grounding in these issues. I thank you for your contribution to this hearing which will provide the context for the more detailed hearings that we will be holding in September and October on some of the specific issues that are internal to nuclear power.

Thank you again for your participation in today's hearing. It has been a most enlightening discussion.

This hearing is adjourned.

[Whereupon, at 12 noon, the subcommittee was adjourned, to reconvene at the call of the Chair.]

[Statements submitted for the record follow:]

TESTIMONY OF

LINDA G. STUNTZ

DEPUTY UNDER SECRETARY FOR POLICY

U.S. DEPARTMENT OF ENERGY

CONCERNING

THE U.S. ELECTRICITY SUPPLY/DEMAND OUTLOOK AND THE POTENTIAL ROLE OF NUCLEAR POWER

BEFORE THE

NUCLEAR REGULATION SUBCOMMITTEE OF THE

SENATE COMMITTEE ON THE ENVIRONMENT AND PUBLIC WORKS

AUGUST 1, 1990

Good morning, Mr. Chairman and Members of the Committee:

I am pleased to have the opportunity to present the Department of Energy's views on the outlook for U.S. electricity supply and demand and the potential role nuclear power may play in meeting that demand. Supplies of reliable, cleanly produced, and reasonably priced electricity are absolutely essential to our Nation's economic and environmental well-being. An inadequate or unreliable electricity system can hinder economic growth and prosperity, prevent the creation of new jobs, and (as many of us have discovered this summer) degrade the quality of life for our citizens. Electricity generated at excessive cost will undermine our ability to compete effectively in the international marketplace. Electricity generated without proper environmental safeguards can foul our air and water supplies.

Our electricity requirements are expected to grow substantially over the long term. How the Nation meets these requirements is a very critical issue. Due to a combination of sustained economic growth and extreme weather conditions, peak electricity demand grew relatively rapidly in the latter 1980s (reaching nearly 4.3 percent per year for 1986--1988). Few analysts anticipate sustained, long-term peak growth at 4.3

percent. However, few analysts projected the 1986-88 growth rate either.

The Department of Energy, as well as many other energy organizations, expects electricity demand to grow at a rate only slightly less than the gross national product (GNP). Our most recent National Energy Strategy (NES) reference case, which assumes a large national increase in energy efficiency, projects electricity demand to grow at an annual rate of 2.3 percent between 1990 and 2010.

Conservation efforts can reduce the rate of demand growth, but they cannot entirely supplant the need for a substantial quantity of additional generating capacity. Especially in light of heightened concerns about emissions from fossil-fueled power plants, this large prospective requirement has given new significance to the outcome of the ongoing vigorous debate about the role of nuclear power in this country. Nuclear power generation has air emissions and water effluents that are significantly less than emissions and effluents from other energy sources. These are heat, dispersed using cooling towers or once-through water cooling systems on rivers or coast lines, and the radioactive remnants of nuclear fuel.

I. Where We Get Our Electricity (Chart 1)

Chart 1 shows the projected 1990 fuel mix for electric generation: coal - 55%, nuclear - 19%, renewables (including hydro) 11%, natural gas - 9%, and oil - 5% (most of it used in the Northeast).

II. Energy for an Expanding Economy (Chart 2)

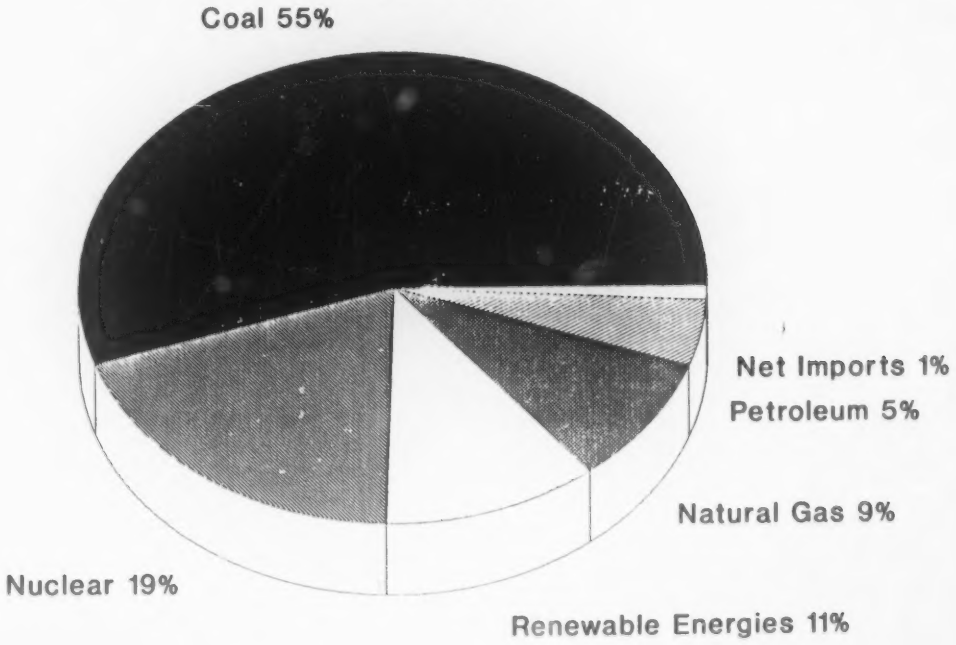
Projecting energy demand accurately is no easy task. Prior to the early 1970s, the growth rate of aggregate energy demand was roughly equivalent to the growth rate in GNP. However, between 1973 and 1986 there was virtually no change in U.S. demand for energy while GNP increased 35 percent. This happened for four reasons:

1) Rapidly rising energy prices stimulated development and adoption of new technologies (e.g., more efficient automobiles, appliances, industrial equipment). Many of these efficiencies are inherent in advanced production technologies. New technologies were responsible for about 67 percent of the reduction in energy use intensity in the 1973-86 period.

Chart 1

Projected Composition of 1990 Generation, by Fuel Type

(Utilities Only)



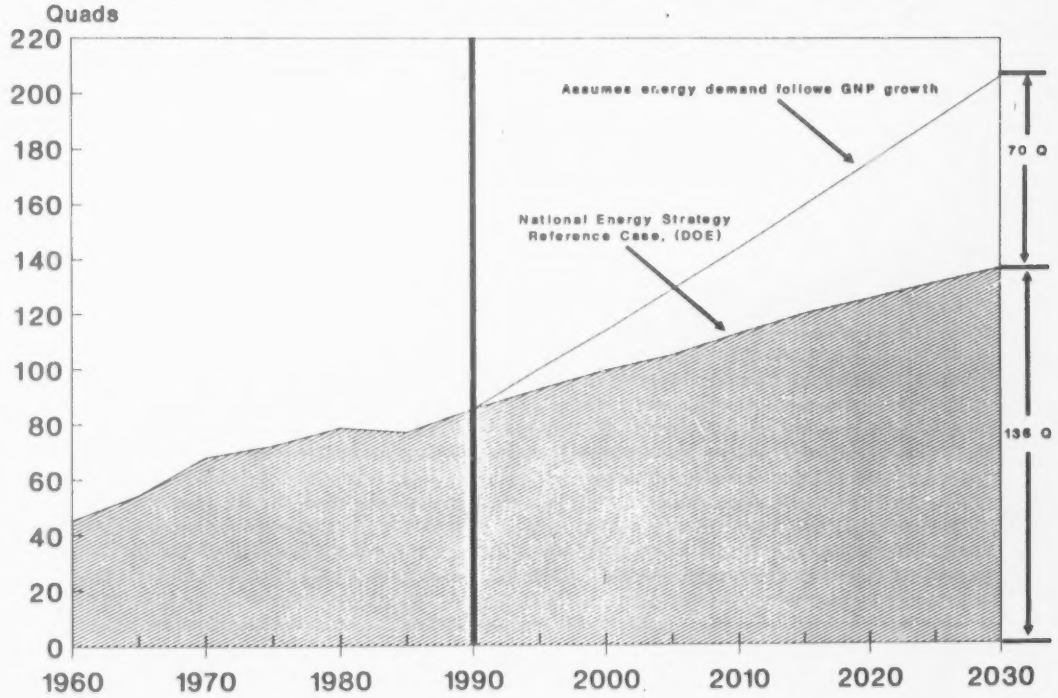
Source: EIA, Annual Energy Outlook, 1990

2) For the past 15 years most U.S. economic growth has occurred in sectors of the economy that consume comparatively little energy per dollar of sales. High technology manufacturing and service industries have grown much more rapidly than the aggregate economy. This structural change in the economy resulted in about a quarter of the decline in energy use per dollar of GNP.

3) Higher energy prices also spurred changes in consumer behavior. For example, people who paid little or no attention to their thermostats began to make substantial adjustments. These changes, which some might consider sacrifices in amenities, were responsible for about 6 percent of the decline in energy use per dollar of GNP.

4) The U.S. trade imbalance during the 1980s meant that the U.S. was importing far more energy embedded in imported products than it was exporting. When we import an automobile instead of manufacturing it domestically, our energy use and GNP are both affected. The effect, however, is difficult to quantify. The

Chart 2
Forecasted Growth in Energy Demand



Sources: National Energy Strategy Reference Case, (DOE)

growing trade imbalance may have reduced U.S. energy demand by as much as 5 percent between 1972 and 1985.

The energy growth rates in chart 2 are based on the assumption that GNP increases at an annual rate of 2.6 percent between 1990 and 2010, and the lower annual rate of 1.8 percent between 2010 and 2030. The slowdown in GNP growth does not result from a stagnating economy. Rather, it is because the growth rate of the size of the U.S. work force declines.

If energy demand growth moves in lockstep with GNP growth, as has occurred during the last four years, annual energy use more than doubles from our estimated 1990 value of 85 quads to over 200 quads by the year 2030. However, we expect that innovations and structural change in the economy will continue, and that GNP can grow without energy growth continuing in lockstep. Under the assumptions made in the current National Energy Strategy (NES) reference case, energy consumption in 2030 is projected to be only about 136 quads, 75 quads less than the 2030 consumption that would occur if energy demand growth simply tracked projected GNP growth. This is equivalent to an annual energy growth rate of 1.2 percent from 1990 through 2030.

It is important to note that even with the large national increase in energy efficiency assumed in this reference case, energy demand continues to increase.

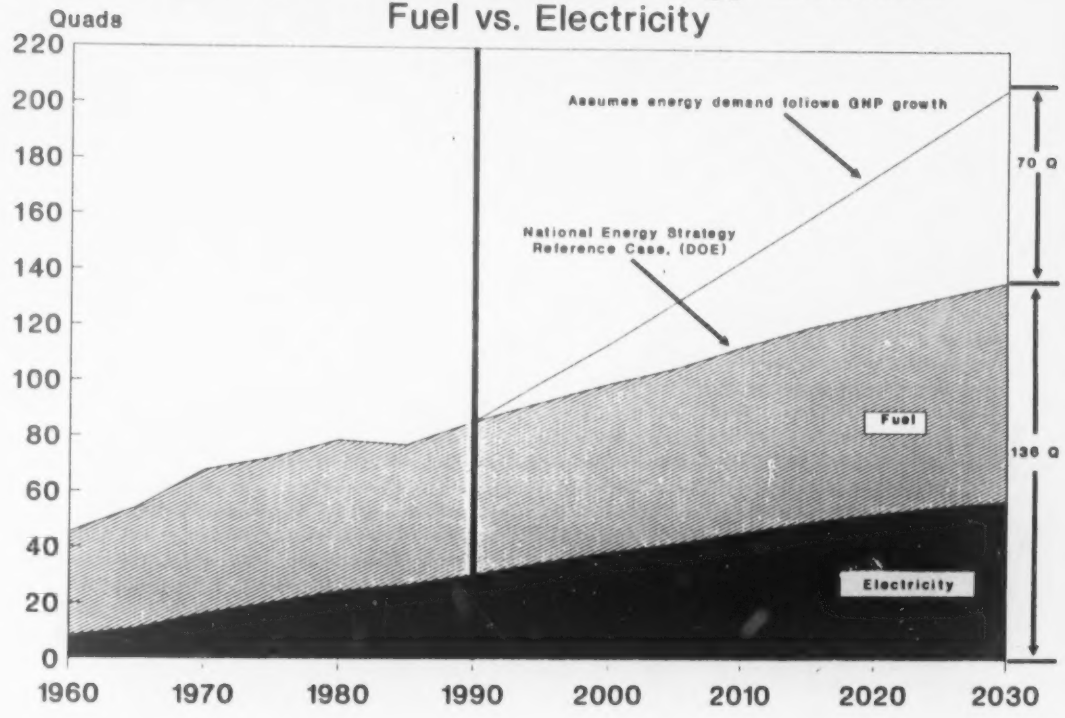
III. Electricity Share of Total Energy Use (Chart 3)

Electricity has been, and is expected to continue, meeting an increasing share of the Nation's energy needs. While total U.S. energy consumption was flat between 1973 and 1986, electricity consumption tracked the growth in GNP. In 1970, electricity accounted for 24 percent of the primary energy consumption in the U.S. In 1990, we expect this figure to be about 36 percent. As shown in Chart 3, the trend toward increased electricity use (even as the economy becomes less energy-intensive) is expected to continue. By 2010, electricity is expected to account for over 40 percent of total energy consumption. The electricity share is expected to continue rising at least through 2030.

Several factors explain the steady trend toward a larger market share for electricity. Two of these are:

Chart 3

Forecasted Growth in Energy Demand: Fuel vs. Electricity



Sources: National Energy Strategy Reference Case, (DOE)

1) Many current energy service requirements that are met economically only by electricity-powered technologies are increasing in use. Examples include lighting, electronic communications, and data management systems.

2) New applications for electricity are continuing to appear in a high-technology economy, especially as we have become more concerned about pollution at the place of use.

We are optimistic that efficiency improvements will moderate electricity demand. Many state regulatory commissions are presently implementing a process known as "least-cost utility planning" or "integrated resource planning" (IRP). A primary goal of IRP is to have utilities explicitly consider demand-side efficiency investments along with capacity investments as a way to balance electricity supply and demand. IRP is a recent development. As it evolves, we expect that demand-side efficiency investments will significantly reduce the Nation's electricity requirements from these projections.

Policy makers are aware that several market imperfections and regulatory distortions may keep utilities and their customers from making cost-effective efficiency investments. There is

presently a vigorous discussion within the utility and regulatory communities about the best ways to overcome these obstacles.

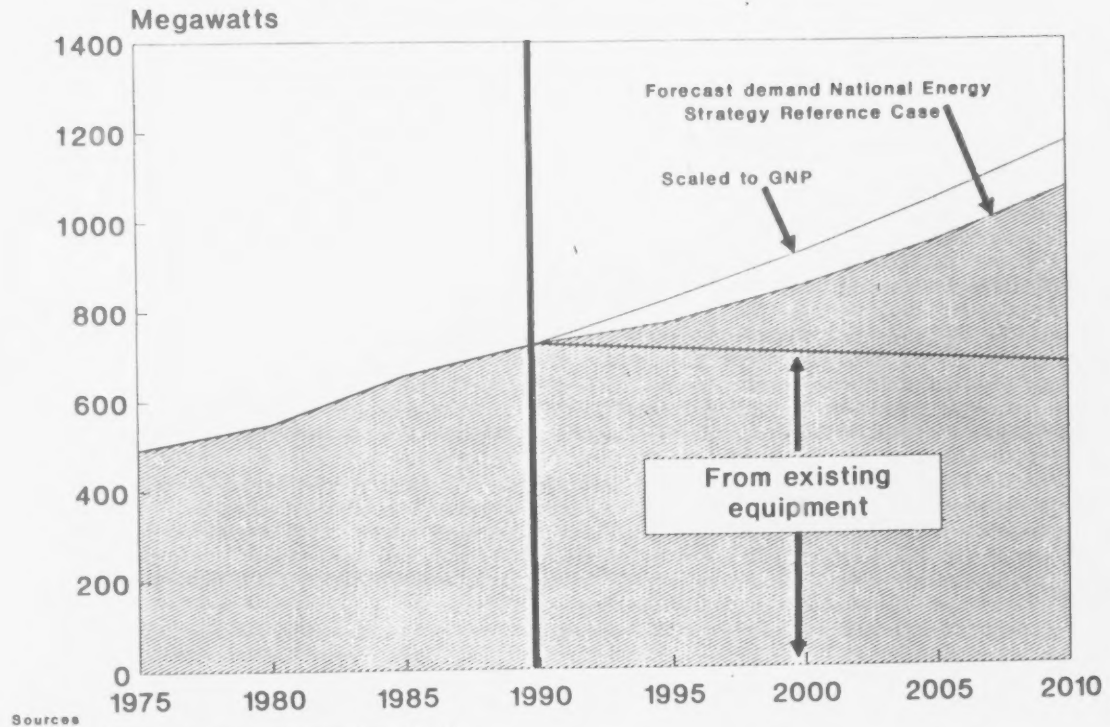
IV. Electric Capacity: How Much New Capacity Will We Need and When? (Chart 4)

The Nation presently has about 700 gigawatts (GW) of installed electric generating capacity. Under the NES reference case, we would have to increase our generating capacity to about 920 GW by 2010 to meet the forecasted increase in demand.

The amount of new capacity needed, however, depends not only on demand growth, but also on the amount of existing capacity retired from service. Much of our existing generating capacity came on line between 1965 and 1975, with a design life of up to 40 years. Soon after the year 2000, much of this capacity will need to be replaced or substantially refurbished.

In chart 4, existing electric capacity declines slowly, reflecting assumptions that the lives of many existing coal-fired plants will be extended. In this chart it is also assumed, incorrectly we hope, that there is no plant life extension for existing nuclear plants. The effect of this assumption, however,

Chart 4
Growth in Electric Capacity Demand



Sources
National Energy Strategy Refergnce Case (DOE)
EIA Annual Energy Review 1988 (p209)

is not realized until after 2010, when many existing nuclear plants begin to retire under current license agreements.

Neither this NES reference case nor the *1990 Annual Energy Outlook*, published by the Energy Information Administration, attempts to project the impact of amendments to the Clean Air Act or other major policy changes. Passage of Clean Air Act amendments similar to those contained in S.1630 is not likely to affect electricity demand significantly, but would alter the mix of fuels that produce our electricity.

Concerns over greenhouse gases, trace toxic emissions from coal and the sulfur oxides and nitrogen oxides in fossil fuels are likely to stimulate demand for non-combustion sources of electricity. At current forecasted levels, the U.S. is expected to increase annual CO_2 emissions from 1990 by about 25 percent by the year 2005. The developing countries' emissions growth is expected to be even more rapid. To reduce CO_2 emissions relative to present levels would require reductions in fossil fuel use and substantial changes in the mix of fuels used to generate electricity.

DOE is evaluating the costs and effects of policies to reduce greenhouse gas emissions as part of developing the

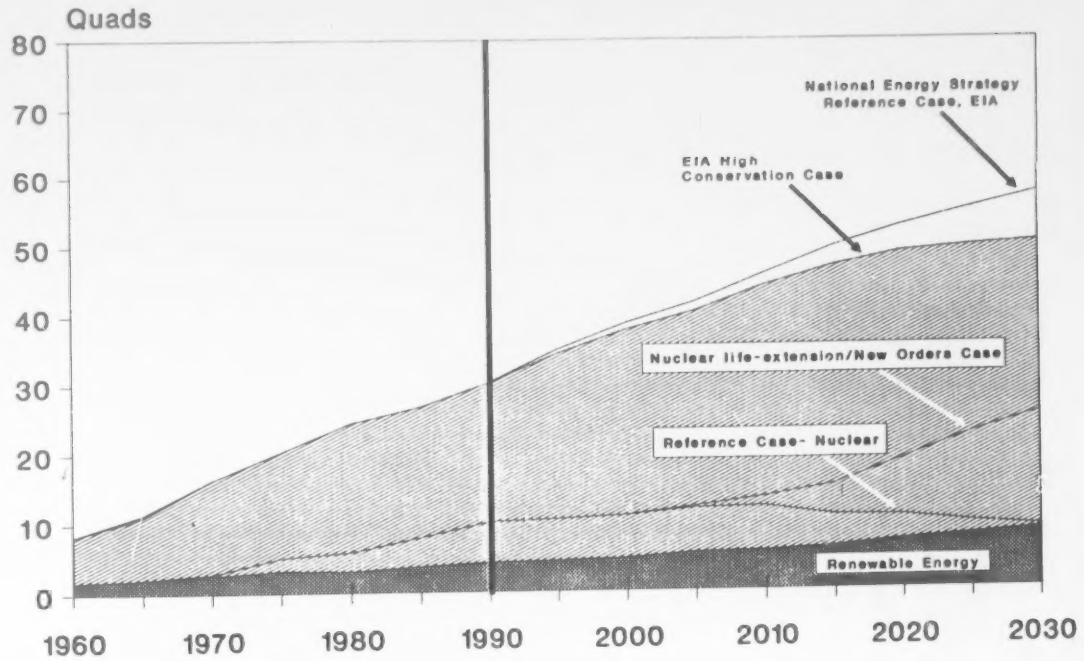
National Energy Strategy and at the direction of Congress. A recent study by Dr. Dale W. Jorgenson of Harvard suggests that sharp increases in energy prices resulting from the imposition of taxes on fossil fuels intended to stabilize emissions of carbon dioxide could have the same debilitating effects on our economy as the oil price shocks of the 1970's. Work done by Alan S. Manne of Stanford University and Richard S. Richels of the Electric Power Research Institute found that stabilizing carbon emissions at 1990 levels through 2000, reducing them to 80% of this level by 2020 and stabilizing them thereafter would cost the economy $3.6 trillion in 1990 dollars.

V. Electricity from Renewables, Conservation, and Traditional Generation Sources (Chart 5)

This chart shows our current view of the contributions that renewables and possible additional conservation could make to our future electricity supply. The top wedge shows the decrease in demand that could result from additional conservation efforts, beyond those significant efforts already embedded in the NES reference case.

The bottom portion of the chart shows the projected contribution from renewable technologies to electricity supply in

Chart 5
Projected Consumption of Primary Energy for Generation
1990 - 2010



• Sources: *National Energy Strategy Reference and High Conservation Cases, EIA* ; National Energy Stategy interlaboratory White Paper for Renewable Energy

the reference case. Renewable capacity is projected in this scenario to increase from 99 GW in 1990 to 133 GW in 2010. About 56 percent of the increase in renewable generation is provided by biomass (10.9 GW) and geothermal (8.3 GW) capacity. There will also be an additional 5 GW of hydro capacity and an additional 3 GW of wind powered capacity. In the reference case, there is a modest growth (1.4 GW) in solar thermal capacity and a relatively insignificant growth (< 1 GW) in photovoltaic capacity.

The major feature of Chart 5 is the large wedge in the middle, the energy which would have to be supplied from traditional generation sources (coal, nuclear, gas, or oil).

In the reference case, the Nation will need to construct a substantial amount (over 200 gigawatts) of new capacity over the next 20 years. In the near term, we expect natural gas to be the fuel of choice for much of this capacity. The natural gas share of the electricity generation fuel mix is expected to increase from 9 percent in 1990 to 16.5 percent in the year 2000. Gas is an attractive choice now because of its comparatively low price and because the capital cost per kilowatt of a combined-cycle gas-fired generating unit is half that of a conventional coal-fired plant with a scrubber.

However, since gas prices are projected to increase relative to coal prices over time, coal-fired generation would become the economic choice for many utilities after the year 2000. Assuming current trends continue with no major policy changes, coal's share of the fuel generation mix would grow from 50 percent in 2000 to 56 percent by 2010. By 2030, coal's share of the generation mix could rise as high as 78 percent.

Meeting greenhouse gas emission restrictions would require greater reliance on low or non-emitting technologies and the promotion of conservation-induced reductions in demand. If the current obstacles to nuclear power remain, the burden of meeting greenhouse gas reductions, while satisfying the Nation's electricity requirements, would fall heavily upon natural gas, renewable generation and on demand-side efficiency investments. While natural gas, renewables and demand-side investments certainly will play an important role in any greenhouse gas reduction strategy, we seriously question whether total reliance on these options would be a least-cost solution and whether it would maintain supply adequacy and economic vitality.

Without new nuclear construction or life-extension of existing nuclear capacity, nuclear generation would all but disappear by the year 2030. This could happen because of

continued nuclear regulatory and licensing uncertainties, financial risk, operating economics and public opposition, all of which make the nuclear option unattractive for utilities and their state regulators. In addition, nuclear plants have an operating life that is limited in part by the life of structural materials, but also in part by the 40-year term of the operating license. With proper attention to examination and replacement of structural materials, operating license terms may be extended.

Overcoming current barriers to nuclear power requires several initiatives, some federal and some from the nuclear industry. Nuclear construction must be carefully managed in order to minimize construction costs and assure safety. The nuclear supply industry must select a small number of standard plant designs to facilitate licensing and enhance economics. Attempts to alter designs for each new customer must be resisted. Public confidence in nuclear power must be restored, perhaps through the use of passively safe reactors. Above all, nuclear power must once again become economically attractive to electric utilities and their customers. Nuclear construction costs can be reduced by a licensing process that is efficient and reliable while protecting public safety. Operating costs can be reduced by achieving higher capacity utilization through better maintenance and management.

If the current barriers to increased use of nuclear power can be overcome, nuclear power could potentially supply a large fraction of the new electricity generating capacity needed between 2010 and 2030. As shown in Chart 5, with new nuclear units and nuclear plant life extension, nuclear power would comprise 17 percent of electricity generation in 2010. This would rise to 27 percent by the year 2030.

Conclusion

The surest thing about energy supply, demand, and price forecasts is that they will be wrong. Nevertheless, it is instructive to look ahead, not because we can forecast with precision, but because there are limits and relationships that need to be visualized and understood. Decisions made in the near future about nuclear plant life extension and design approval will largely determine whether we have a growing nuclear generation capability or an eventual decline in nuclear generation. The Nuclear Regulatory Commission has just issued a proposed rule to provide for 20-year renewals of existing nuclear power plant licenses. This is an important and promising development for nuclear power. If nuclear generation declines, it is important to understand what the alternatives are, as well as their cost and reliability.

Based on our present knowledge of the future, we believe that we cannot, as a nation, afford to lose the nuclear power option.

33-745 O - 90 - 3

TESTIMONY BEFORE SUBCOMMITTEE ON NUCLEAR REGULATION OF THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS UNITED STATES SENATE

CHAIRMAN MICHAEL WILSON
FLORIDA PUBLIC SERVICE COMMISSION

AUGUST 1, 1990

GOOD MORNING, MR. CHAIRMAN, SENATORS. I AM MICHAEL WILSON. I AM CHAIRMAN OF THE FLORIDA PUBLIC SERVICE COMMISSION. I AM ALSO THE CHAIRMAN OF THE SUBCOMMITTEE ON NUCLEAR ISSUES/NUCLEAR WASTE SUBCOMMITTEE OF THE ELECTRICITY COMMITTEE OF THE NATIONAL ASSOCIATION OF REGULATORY UTILITY COMMISSIONERS (NARUC), AN ORGANIZATION CONSISTING OF UTILITY REGULATORS FROM THE 50 STATES, THE DISTRICT OF COLUMBIA, PUERTO RICO AND THE VIRGIN ISLANDS.

I DO NOT APPEAR HERE TODAY AS AN OFFICIAL OF NARUC, NOR TO PRESENT A FORMAL POSITION OF THE FLORIDA PUBLIC SERVICE COMMISSION, BUT TO SHARE SOME CONCERNS AND MAKE SOME OBSERVATIONS.

BECAUSE OF THE RATE OF POPULATION GROWTH AND THE CONSEQUENT EFFECT ON THE DEMAND FOR ELECTRICITY, THE CIRCUMSTANCES IN THE STATE OF FLORIDA MAY PROVIDE A USEFUL BACKDROP FOR THE POINTS I WANT TO MAKE.

PROJECTIONS SHOW THAT FLORIDA WILL NEED APPROXIMATELY 7,000 MEGAWATTS OF POWER BY THE YEAR 2000. AND, BASED ON CURRENT PROJECTIONS, FLORIDA WILL NEED ALMOST 15,000 MEGAWATTS BY THE YEAR 2010. WHETHER THAT NEED IS MET BY CONSERVATION, UTILITY CONSTRUCTED GENERATION, COGENERATION OR OTHER NON-UTILITY GENERATION, FLORIDA WILL NEED ADDITIONAL SUFFICIENT CAPACITY EQUAL TO THE SIZE OF THE ENTIRE EXISTING SYSTEM OF OUR LARGEST ELECTRIC UTILITY, FLORIDA POWER AND LIGHT. FLORIDA POWER AND LIGHT IS THE FOURTH LARGEST UTILITY IN THE UNITED STATES. IT PRESENTLY SERVES 3.18 MILLION CUSTOMERS IN CITIES SUCH AS MIAMI AND FT. LAUDERDALE.

WITH AGGRESSIVE CONSERVATION PROGRAMS, FLORIDA HAS BEEN ABLE TO REDUCE THE RATE OF GROWTH IN PER CUSTOMER DEMAND; ALTHOUGH WITH THE ADDITION OF AN AVERAGE OF 190,000 CUSTOMERS PER YEAR OVER THE LAST 10 YEARS, OVERALL DEMAND HAS INCREASED. WHEN PEOPLE MOVE TO FLORIDA, THEY BRING THEIR ELECTRIC NEEDS WITH THEM. THROUGH THE 1980'S, WE SAW DECREASES IN PER CUSTOMER DEMAND, IN THE MID 80'S A LEVELING OF DEMAND, AND IN RECENT YEARS A RESUMPTION IN THE PER CUSTOMER GROWTH IN DEMAND. DURING THE NEXT DECADE, WE WILL CONTINUE TO PURSUE AGGRESSIVE CONSERVATION MEASURES. WE ARE ALSO EMBARKING ON NEW PROGRAMS OF DEMAND SIDE MANAGEMENT TO ATTEMPT TO CONTROL THE GROWTH OF PEAK DEMAND, AND WE HAVE ACCELERATED INSTALLATION OF LOAD MANAGEMENT MEASURES. HOWEVER, CONSERVATION AND DEMAND SIDE MANAGEMENT MEASURES ALONE WILL NOT OVERCOME THE NEED TO CONSTRUCT NEW GENERATION IN FLORIDA.

DURING THE CHRISTMAS HOLIDAYS, IN FLORIDA WE EXPERIENCED EXTRAORDINARILY COLD WEATHER. AND WE FACED ELECTRICITY DEMAND LEVELS WHICH WERE NOT ANTICIPATED TO BE REACHED UNTIL 1996.

OUR DEMAND GROWTH PROJECTIONS ARE BASED ON CURRENT LEVELS AND TYPES OF ELECTRICITY USAGE. BUT, AS WE ALL CAN OBSERVE, OUR SOCIETY IS EXPERIENCING INCREASING ELECTRIFICATION IN ALMOST EVERY ASPECT OF OUR LIVES: AIR CONDITIONING, HEATING, ENTERTAINMENT, HOUSEHOLD APPLIANCES, INDUSTRIAL PROCESSES, AND WE MAY SOON SEE THE ADVENT OF ELECTRIC CARS.

ONE OF MY DUTIES AS A PUBLIC SERVICE COMMISSIONER IS TO ASSURE THAT THERE IS AN ADEQUATE SUPPLY OF ELECTRICITY AS DEMANDED BY CUSTOMERS OF UTILITIES IN FLORIDA. UTILITIES ARE REQUIRED TO COME TO THE COMMISSION FOR A DETERMINATION OF NEED FOR GENERATION PLANT;

WE REVIEW THE PROJECTED DEMAND, BUT WE ALSO REVIEW ALTERNATIVE CONSTRUCTION TECHNOLOGIES AND COMPARATIVE COSTS. I FIND THE RANGE OF CHOICES NARROWING; COSTS ARE INCREASING. SERIOUS DRAWBACKS EXIST TO ALL GENERATING TECHNOLOGIES AND FUEL CHOICES. THE GENERATING OPTIONS AVAILABLE TO FLORIDA'S UTILITIES INCLUDE SOLAR, NUCLEAR, COAL, GAS AND OIL. SOLAR GENERATED ELECTRICITY REQUIRES AN ENORMOUS AMOUNT OF LAND AND IS NOT ECONOMICAL AT THIS TIME. NUCLEAR GENERATION IS FACED WITH PROBLEMS I WILL DISCUSS LATER. GAS IS CURRENTLY CONSTRAINED BY PIPELINE CAPACITY AND BY UNCERTAINTY OF LONG TERM SUPPLY BEYOND CURRENT COMMITMENTS. OIL, PARTICULARLY IMPORTED OIL, PRESENTS STRATEGIC AS WELL AS PRICE CONCERNS. AS OF NOW, UNFORTUNATELY, COAL SEEMS TO BE THE BEST AVAILABLE OPTION FOR THE LONG TERM. BUT YOU ARE CERTAINLY AWARE, FROM THE DEBATE OVER ACID RAIN LEGISLATION, OF THE SERIOUS ENVIRONMENTAL IMPACTS OF COAL-FIRED GENERATION. THE COSTS FOR COUNTERING THE EFFECTS OF ACID RAIN DEPOSITION ARE GOING TO BE HIGH. THE CURRENT ESTIMATE FOR FLORIDA IS OVER $7 BILLION OVER THE NEXT TEN YEARS. EVEN AS ACID RAIN PROBLEMS ARE BEING ADDRESSED, CONCERN ABOUT AND MOVEMENT TOWARD MITIGATION OF THE EFFECTS OF GLOBAL WARMING IS INCREASING.

IT IS DIFFICULT TO EVALUATE THE CONCERNS ABOUT THE ENVIRONMENTAL IMPACT OF COMBUSTION FUELS WITHOUT, IN THE SAME BREATH, CONSIDERING THE GENERATION OF POWER THROUGH NUCLEAR FISSION.

AS A REGULATOR WHOSE JOB IS TO ASSURE RATEPAYERS AN ADEQUATE SUPPLY OF RELIABLE, REASONABLY PRICED ELECTRICITY, I AM CONCERNED THAT WE HAVE THAT SUPPLY OF ELECTRICITY. I HAVE NO EMOTIONAL ATTACHMENT TO SOURCES OF ELECTRICITY. ALTERNATIVE SOURCES OF

ELECTRIC GENERATION SHOULD BE RATIONALLY APPRAISED AND EVALUATED ACCORDING TO THEIR ECONOMIC AND SOCIETAL COSTS. I AM CONCERNED WITH NOT HAVING THOSE CHOICES TO MAKE.

IN THE GENERATION EXPANSION PLANS OF FLORIDA'S ELECTRIC UTILITIES, NOT ONE INCLUDES NUCLEAR GENERATION. NUCLEAR POWER, IN 1989, PROVIDED 22% OF THE GENERATION IN FLORIDA AND 19% NATIONWIDE.

THE FEDERAL GOVERNMENT, AND THE CONGRESS, PLAY A VITAL ROLE IN THE ROLE OF NUCLEAR POWER IN THIS COUNTRY. FROM THE FABRICATION OF FUEL TO THE DISPOSAL OF WASTE, THE FEDERAL GOVERNMENT CONTROLS THE DIRECTION AND VIGOR OF THE NUCLEAR INDUSTRY. AS YOU EXAMINE THE ROLE OF NUCLEAR POWER, THE AREAS INTO WHICH YOU SHOULD INQUIRE ARE FAIRLY CLEAR.

FIRST, THE LICENSING PROCESS MUST BECOME MORE CERTAIN. A UTILITY, ITS INVESTORS, WALL STREET, STATE REGULATORY COMMISSIONS MUST KNOW THAT A NUCLEAR POWER PLANT, ONCE PERMITTED FOR CONSTRUCTION BY THE NUCLEAR REGULATORY COMMISSION, MUST CARRY WITH IT THE EXPRESS COMMITMENT THAT, IF IT IS BUILT ACCORDING TO SPECIFICATIONS, IT WILL RECEIVE A LICENSE TO OPERATE IN A TIMELY MANNER. NO UTILITY WILL ORDER AND NO STATE COMMISSION WILL AUTHORIZE CONSTRUCTION OF A NUCLEAR PLANT WITH OPEN-ENDED LIABILITY ON COSTS AND DESIGN. THERE MUST BE CLOSURE WITH CONSTRUCTION LICENSING AND OPERATING LICENSING. YOU MAY ALSO WISH TO CONSIDER IMPOSING STRICT TIME LIMITS ON PROCEEDINGS BEFORE THE NRC. FLORIDA'S COMMISSION HAS STATUTORY TIME CONSTRAINTS BY WHICH ALL PARTIES AND THE COMMISSION ARE BOUND.

SECOND, THE FEDERAL GOVERNMENT'S RESPONSIBILITY FOR THE DISPOSAL OF HIGH LEVEL NUCLEAR WASTE MUST BE FULFILLED. BILLIONS

OF DOLLARS OF RATEPAYERS' MONEY HAS BEEN COLLECTED AND BILLIONS SPENT IN THE FRUSTRATING PURSUIT OF A DISPOSAL SITE. I AM EXTREMELY ENCOURAGED BY THE DEPARTMENT OF ENERGY'S CURRENT EFFORTS UNDER THE VERY CAPABLE LEADERSHIP OF THE SECRETARY, ADMIRAL WATKINS. THE DEPARTMENT HAS DISPLAYED AN OPENNESS TO OUTSIDE COUNSEL AND ADVICE, AND HAS TAKEN POSITIVE STEPS TOWARD RESOLUTION OF THIS PROBLEM.

BUT THE MOST EFFICIENT AND SCIENTIFICALLY SOUND MEANS OF CONFRONTING THE PROBLEM OF HIGH LEVEL NUCLEAR WASTE MAY REQUIRE THE RECONSIDERATION OF THE ROLE OF AN MRS (MONITORED RETRIEVABLE STORAGE SYSTEM), AND THE ROLE OF REPROCESSING OF SPENT FUEL.

THE ISSUES SURROUNDING NUCLEAR POWER IN THIS COUNTRY ARE SERIOUS AND INVOLVE IMPORTANT CONSIDERATIONS OF ENERGY INDEPENDENCE, ENVIRONMENTAL DAMAGE, GLOBAL WARMING/GREENHOUSE EFFECT, AND POTENTIALLY, AMERICA'S COMPETITIVE POSITION IN A WORLD ECONOMY.

AS A UTILITY REGULATOR, I WANT TO HAVE GOOD CHOICES AVAILABLE TO ME TO MEET THE ENERGY NEEDS OF THE CITIZENS OF THE STATE OF FLORIDA. WHILE MY STATUTORY DUTIES DO NOT INCLUDE ENVIRONMENTAL REGULATION, I AM NOT UNMINDFUL OF THE THREATS TO THE QUALITY OF OUR ENVIRONMENT, AND I WOULD LIKE TO MEET THAT NEED WITH THE MOST ENVIRONMENTALLY BENIGN SOURCE OF ENERGY FEASIBLE.

IF I, OR NARUC, CAN BE OF ANY ASSISTANCE IN YOUR CONSIDERATION OF THIS SUBJECT, YOU HAVE BUT TO CALL ON US.

THANK YOU FOR THE OPPORTUNITY TO ADDRESS YOU.

Summary Statement of
Michehl R. Gent, President
Nor h American Electric Reliability Council

Before the
Senate Subcommittee on Nuclear Regulation
Committee on Environment and Public Works

August 1, 1990

Electric utilities in the United States are counting on a wide variety of both demand management and new supply options to meet a demand for electricity that is expected to be 20% higher in ten years. Over 84,000 MW of new capacity resources, only 11% of which are nuclear, are planned to be added to the existing supply of nearly 675,000 MW over the next ten years. Of the remaining additions, 35% are oil or gas-fueled, 19% are non-utility generators, and 16% are coal-fired.

These plans are adequate, but they are not without risk. Many things can affect the timing and success of planned capacity additions, the continued operation of existing capacity, or the future demand for electricity.

- **Environmental Impacts** — Acid gas emissions legislation and electric and magnetic field (EMF) regulations have the potential to produce significant impacts on electric system reliability. Proposed amendments to the Clean Air Act have the potential for requiring 7,400 MW of additional generating capacity by 1999.

- **Fuel Supply Uncertainty** — The use of natural gas is expected to increase dramatically. Short lead-time supply options such as combustion turbines and many of the non-utility generators (NUGs) will use natural gas. Also, potential environmental constraints on the use of coal will make less coal-fired economy energy available and increase the use of natural gas. Significant uncertainties exist regarding the future availability and deliverability of natural gas.

- **Increased Availability of Generators** — Reliability in many Regions is premised on the assumption that historical on-peak availability rates of generators can be improved by eliminating or moving scheduled maintenance from peak demand periods and by reducing forced outage rates. Should these assumptions prove false, neighboring systems will be asked to supply the capacity.

- **Unspecified Capacity** — Reluctance to identify specific future capacity resources beyond five years has become widespread. This is due in part to the reliance on short-term options to forestall or prevent capacity deficiencies. There is a concern, however, that commitment to a specific course of action still may not be taken in time to assure that the option is available for service when needed.

- **Transmission Deficiencies** — Transmission system deficiencies exist in many areas. Facilities have not been constructed as planned, and are being used in ways not planned for. The complexity of operating the transmission systems will continue to increase and be compounded by more participants or new patterns of use.

- **Disincentives** — Regulatory disallowances, delays, inconsistencies, and uncertainties have created powerful disincentives impeding the construction of additional generation and transmission facilities needed to maintain reliability.

- **Demand Uncertainty** — Making accurate electricity forecasts is becoming more difficult because of the increasing uncertainty in socio-economic variables. The recent trend of actual demands exceeding forecasts underscores this difficulty. Underestimating the future demand for electricity can lead to supply shortfalls.

Today's discerning public expects electric utilities and their regulators to have at least as high a regard for the environment as for the traditional goals of safety, reliability, and economics. This introduces critical trade-offs that require balanced decision-making. It is important that utilities and public policymakers work together to provide a safe, reliable, and economical electricity supply while protecting the environment.

TESTIMONY TO

SUBCOMMITTEE ON NUCLEAR REGULATION

COMMITTEE ON THE ENVIRONMENT AND PUBLIC WORKS

U.S. SENATE

BY

JOHN J. TAYLOR

VICE PRESIDENT, NUCLEAR POWER

ELECTRIC POWER RESEARCH INSTITUTE

PALO ALTO, CALIFORNIA

August 1, 1990

Introduction

The Electric Power Research Institute (EPRI) welcomes the invitation to discuss the role of nuclear power in meeting increases in demand for electricity in the United States. With the Committee's responsibility for addressing the environmental issues confronting our society and this subcommittee's specific responsibility for oversight of the Nuclear Regulatory Commission, your interest in electricity supply and demand and the impact of environmental considerations upon choices for supply is very important. The use of electricity is one of the most effective means at our disposal for meeting and reconciling the environmental and economic objectives of the country.

As you know EPRI is the collaborative research arm of the U.S. electric utility industry. Its role is to provide for the electric utilities and the nation, through the conduct of a rich and diversified research and development program, technology options in electricity end-use, production and delivery so that they may choose those that best suit the conditions of the individual service areas. In all cases the need to minimize environmental impact is one of the key criteria in setting development objectives.

Electricity and economic progress

It is generally recognized that, with its introduction in the late 1800s, electricity has led to major productivity gains in our society and improvements in the quality of life. It has made possible a wide ranging portfolio of technologies: lighting, motors, computers, medical diagnostic equipment to name a few.

Continuing benefits can be foreseen in three major trends:

- A growing share for electricity in the overall energy mix, replacing direct use of primary energy sources.

- Increased productivity which has historically accompanied electrification of the workplace.

- Declining energy intensity in the U.S. economy, due in substantial part to efficiency improvements through the use of electrical technologies.

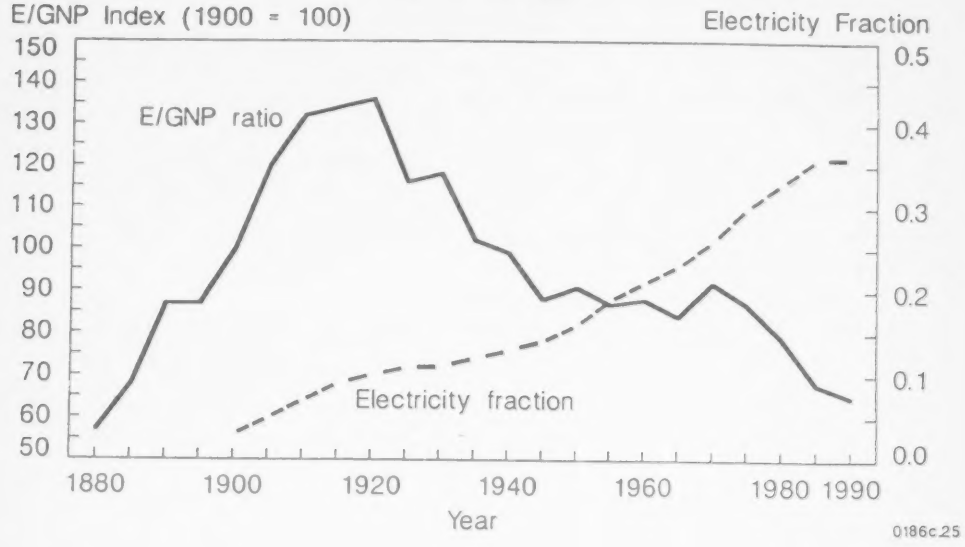
Electricity and Efficiency

While it is generally recognized that electricity has improved the quality of life, it is less widely appreciated that electricity has been a major factor in conserving energy. During the period when the fraction of primary energy used to produce electricity has increased from about 10% in 1920 to over 35% today, the energy used to produce a unit of GNP has decreased by half (see attached figure 1). This occurs, despite thermodynamic losses in the current means of producing electricity, because of the productivity gains electricity makes possible - the ability to control energy precisely in space, time and character. There are many examples of these gains in all energy-using sectors.

Electricity use continues to increase its share of total U.S. energy consumption. Since 1982, for example, electricity growth has paralleled GNP growth, while real electricity price has declined 16% and overall energy efficiency has improved 11%. Improvements in technology for supplying and using electricity promise further increases in energy efficiency.

FIGURE 1

U.S. ENERGY/GNP RATIO AND ELECTRICITY FRACTION 1880 - 1989



33-745 O - 90 - 4

Electricity and the Environment

Informed and prudent use of electricity is also an important part of the solution to our environmental concerns. Because electricity is clean at its point of use, control of waste by-products and emissions can be centralized at the power plant and handled more effectively. Electricity is the most flexible form of energy, enabling the use of a diversity of primary energy sources in forms that allow environmental impacts to be managed. The fact that use of electric technologies increases the efficiency of overall energy use also reduces the net environmental impact of energy consumption.

The Electricity Supply and Demand Balance

The importance of electricity to a healthy and productive economy, and electricity's role in achieving our environmental goals make it extremely important that the nation be assured of an adequate supply of electricity at reasonable cost.

The Electric Power Research Institute does not make independent projections of electricity demand. However, it is generally accepted by a wide range of independent forecasts available that electricity demand will continue to grow. For reasons of environmental preservation and economy, conserving energy when economically feasible is an important objective. Improved efficiency in the use of energy is an important means of protecting the environment, saving resources and improving the quality of life. As noted earlier, efficient use of electricity is an important contributor to that objective, and therefore, extracting maximum efficiency from existing supply sources, delivery, (i.e, transmission and distribution), and end-uses continues to be a very important component of EPRI's R&D program. EPRI has identified significant conservation and efficiency improvement potential in all three areas.

Some examples of conservation and efficiency related achievements and potential are:

- A revolutionary heat pump has been commercialized after 6 years of EPRI research. This heat pump offers 30% more efficiency than current models, and is the most environmentally benign of any HVAC technology.

- Refrigeration systems using multiple compressors and a variety of control strategies show efficiency gains of more than 20%. EPRI is now sponsoring nationwide demonstrations of such advanced designs.

- Electronically controlled adjustable speed drives have the potential to reduce the industrial sector's energy requirements by over 15%.

- Demand-side planning and implementation methodologies have become an established area of EPRI end-use R&D.

However, conservation and efficiency improvements alone will not be sufficient to avoid continued growth in demand for electricity to meet society's future needs.

During the past decade, growth in demand slowed markedly from the previous rates of growth. As a result of this slowdown in demand growth, more capacity has existed than might have been needed to assure reliable supply. Yet, as pointed out above, electric demand growth has continued and still appears to be tied to economic growth. The continued demand growth has been working off the excess capacity to the point that additional capacity is again needed in the 1990's, and certainly beyond.

The challenge of meeting power requirements in the 1990's is only a modest beginning for the larger issues to be faced by the generation sector. The 1990's will see the end of regional excess generating capacity in the U.S., and a reemergence of the need to cope with demand growth in the neighborhood of 2 to 3% per year. Although this sounds modest relative to the 7% per year relative growth of the 1960's , it must be recognized that it implies the addition of 20,000 MWe per year of new capacity by the turn of the century, excluding any replacement of older units.

In addition to the need to provide for incremental demand, there is also the need imposed by the impending retirement of a substantial amount of generating capacity in the next decade and beyond. It is estimated that no less than 300,000 MWe will reach 30 years of age in the next twenty years and be eligible for retirement. The efforts at extending the licenses for existing plants, both fossil and nuclear, are laudable steps in the right direction.

Compliance with clean air legislation being considered by the U.S. Congress will necessitate extensive deployment of capital and engineering and construction expertise for the retrofitting of existing generation facilities at the same time that those resources will be required for new facilities to meet additional requirements. This is another uncertainty clouding the future of electricity supply at a time when reserve margins may already be at or below NERC recommended minimums in parts of the country.

Future Electricity Supply Options

A specific question posed by the subcommittee for this hearing is the projected role of nuclear in meeting future electricity demand. Utility capacity planning is currently based largely on gas and oil fired generation, coal generation, and to a limited extent on renewables. Additional nuclear plants are not in current plans; although we believe the advanced reactor designs being developed promise many improvements in plant safety and economy.

Broadly speaking, the energy sources available to the U.S. to meet future needs are natural gas, oil, coal, nuclear, hydro and other renewables and geothermal.

Natural gas & Oil: The combination of environmental factors and price uncertainty points to a declining share for oil in the future generation mix of the United States. Much of the capacity to be added in the 1990's will be fueled by natural gas, given the current circumstances faced by utilities. However, as the country shifts more applications to the use of this fuel, there are concerns regarding the longer term availability and deliverability of natural gas at reasonable prices. EPRI has recently completed work on the issue of gas market risks which raises issues regarding future prices, deliverability and operations of

the gas supply infrastructure which was never designed with the electric utility industry as a major user in mind.

Renewables and Storage: By producing energy with little impact on the environment, renewable resources have the potential to play an increasingly important role in the years ahead. There have been steady advances in technology to use solar and wind energy. Solar arrays that track the sun and concentrate its light onto small, high-efficiency photovoltaic cells could be contenders for competitive power generation in the late nineties. EPRI research has achieved efficiencies of 28% for these cells. Biomass has the potential to provide both baseload electricity and a variety of liquid and gaseous fuels. Because biomass is a worldwide resource, many studies suggest it could potentially play a significant role among renewables by the middle of the next century. The unsubsidized cost of power from these sources is not yet competitive. But, they are nearing the time when they may be economically feasible in regions of good solar or wind resources. The technology for widespread use to replace baseload fossil and nuclear power, however, is not yet in sight.

The widespread ability to store electricity on a large scale would result in substantial economic, efficiency and environmental gains. Utilities would have greater flexibility in operating their systems, enabling them to increase the utilization of their most efficient generating units and displace units that burn premium fuels during peak periods.

In connection with the expected need for baseload generation in particular, the two most reliable and potentially cost effective options are coal and nuclear. The question for this subcommittee and our society therefore is the identification of the technical and institutional prerequisites to enable these fuels to contribute their fullest potential to our nation's economic and environmental objectives. There are promising developments emerging from constructive collaboration between the Government and the private sector both in clean coal technologies and in nuclear technologies; they are discussed below.

Coal: It is essential that the role of coal be recognized in policy making and legislative activity. It is the predominant fuel for meeting the electric generating requirements of the nation, a role that is expected to continue well

into the next century. It is an abundant domestic resource. Furthermore, new clean coal technologies will enable its use with far less environmental impact. Atmospheric fluidized bed combustion systems are now commercially available. Other clean coal technologies could be commercially introduced in the latter part of this decade. Table 1 itemizes several coal-based technologies and their estimated commercial deployment dates. Although a pulverized coal unit without flue gas desulfurization would not be built under today's regulations, it has been included as a reference, since most of the existing U.S. coal fired generation is based on this technology.

The more advanced coal technologies will have significantly lower emissions of SO_2, NOx, and solid waste than a conventional pulverized coal unit. Coal gasification-based systems can provide the greatest reduction in these emissions and by-products. As coal-based technologies advance there will be further reductions in heat rate, i.e., improved efficiency. The integrated gasification-molten carbonate fuel cell (IGMFC) has the potential of an efficiency improvement of 35% compared to today's conventional coal units.

Concern over the contribution of coal-fired plants to the greenhouse effect, if scientifically determined to be well founded, can also be eased by development of these efficient, advanced, coal-based technologies. The impact of improvement in heat rates in reducing CO_2 emissions is significant; the reduction in CO_2 emissions between a pulverized coal plant with flue gas desulfurization and the IGMFC is more than 37%.

It can be seen that these technology advances offer increased fuel efficiency and reduced costs and also reduce the rate of all emissions including CO_2. Therefore, as environmental policies are considered, it is important that the timely introduction of these advanced coal-based technologies be facilitated.

Table 1.

Coal Based Technologies

Technology	Commercial Deployment
AFBC—Atmospheric. Fluidized-ed Combustion	1995
IGCC—Integrated-Gasification-Combined Cycle	1997
IGHAT—Integrated-Gasification Humid-Air Turbine	2003
IGMCFC—Integrated Gasification Molten-Carbonate Fuel Cell	2010
PC w/FGD—Conventional Pulverized Coal With Flue Gas Desulfurization	Available Now
PC w/o FGD—Conventional Pulverized Coal Without FGD	Available Now
PFBC—Pressurized Fluidized-Bed Combustion	2005
SOAPP—State-the-Art Power Plant (Super Crit. PC Advanced FGD)	2000

Nuclear Power: Nuclear power supplied 20% of the nation's electricity demand in 1989. Yet no new nuclear power plants have been ordered in the United States in more than a decade. Excess base-load capacity, public concerns, regulatory uncertainty and the consequent financial risk facing the utilities have led to this state of affairs. Yet nuclear power can be among the most economic means of producing electricity, and is in many parts of this country and the world. It is interesting to note that at the same time as we have effectively foreclosed the nuclear option for ourselves, at least for now, one of our major trading partners, Japan, recently announced energy plan calls for an increase in nuclear capacity from approximately 30 GW in 1988 to 51 GW in 2000, and further to about 73 GW in 2010. (Recommendation by the advisory committee to Japan's Ministry of International Trade and Industry). France, with 70% of its energy coming from nuclear power, provides Europe with its least expensive power.

The need to maintain a nuclear power option in the U.S. has increased in urgency recently for several reasons:

- The expected need for new baseload electric generation capacity in the late 1990's.
- The need to reduce air pollution caused by electricity production.
- Increased concern regarding the long-term effect of global warming suggests that more attention be accorded to electricity options that reduce emissions of greenhouse gases.

Environmental Benefits of Nuclear Power

The operation of a nuclear power plant produces no SO_2, NOx, CO_2 or other greenhouse gases. Emissions of radiation to the public can be controlled to virtually zero. Let us examine the implications of nuclear power on the issue of global warming in the context of electricity needs. CO_2 emissions from U.S. electric generating stations presently make a very small contribution to the emissions of man-made greenhouse gases. All of the U.S. electric fossil generating stations are estimated to contribute less than 4% of the manmade gases which have a potential to cause global warming. A recent paper by

Chauncey Starr and Milton Searl of EPRI entitled Global Electricity Futures, discussing the long range aspects of CO_2 emissions, concludes that global energy demand in the year 2060 is likely to be so large that only a major expansion of non-fossil sources can slow the global annual increases in CO_2 emissions. Even with a full conservation effort to use energy efficiently, total energy use would almost double, driven by global population increases and global economic growth. This assessment assumes only modest annual increases in the two fundamental forces that will increase energy use: population growth is assumed to average less than 1 percent per year, and economic growth about 2.3 percent per year in world product, most of which is in the underdeveloped world. Electricity demand is likely to increase about four times under these assumptions, and its supply will require a global expansion of sources.

The non-fossil sources that can make a substantial contribution are solar, biomass, hydro, and nuclear. Even if the combination of conservation, solar, and biomass might optimistically contribute about half of needed supply, it clearly identifies the need for nuclear capacity to play an expanded role in the efforts to reduce the rate of CO_2 emissions, along with clean coal technologies.

Other industrialized nations such as France and Japan are seriously engaged in advanced reactor R&D. They recognize the economic and environmental considerations that will make nuclear an attractive option for baseload capacity needs in the next century. They also recognize the fact that there will be an important market for advanced reactor systems.

Prerequisites for the Renewed Use of Nuclear Power

The U.S. utility industry considers that an essential component of a long term energy policy for the U.S. is the reopening of the option for nuclear capacity expansion. The need is urgent because of the long lead-time needed to finance, design, license, and construct a nuclear power plant.

U.S. electric utilities face several obstacles and disincentives in the path of building new nuclear power plants. A reformed licensing process which permits true one-step licensing is a prerequisite, as is timely implementation of the technical and political solutions of the high-level waste issue by the federal government and low-level waste storage by state governments. In addition, a

more tangible acceptance of the need, benefits, and residual risk of nuclear power by all concerned institutions is an essential impetus for the return of the nuclear option.

Nuclear power plants can be competitive in the 1990's, if obstacles which now prevent utilities from ordering them are removed. The utilities can overcome some of these, but there are limits to what the utilities can accomplish by themselves. The Congress, Administration, and state regulators all have essential roles, and for that reason there is a need for national policy support.

Electric utilities will turn back to nuclear power once they are assured it offers economic advantages over other alternatives. To this end, it is an economic goal of the EPRI Advanced Light Water Reactor (ALWR) program that the ALWR have a 10 percent cost advantage over alternatives after the first 10 years of operation and a 20 percent advantage after 30 years.

In order to meet this goal, the program has established a number of general design requirements. The most important variables in the economics of nuclear power are the length of construction schedules and plant availability. The EPRI ALWR program has established ambitious design requirements in both of these areas in order to assure improvements in plant economics. For example, EPRI has established a goal of six years or the total time from owner commitment to construct to commercial operation. This is comparable to construction schedules in France and Japan, and much less than recent experience in the United States. Moreover, the EPRI program has design features to achieve an availability goal of 87 percent. If these goals are met, nuclear plants will likely have a clear economic advantage over alternatives.

Some key needs stressed by the industry are:

- Federal regulation of safety must be predictable and preempt state and local safety regulation.

- Rate regulation must be fair, providing a balance between financial risk and financial reward.

- The operational improvement progress on the present plants must continue, so as to demonstrate continued safe, accident-free operation

and superior reliability and economy comparable to other baseload generating alternatives, and to provide a sound basis for obtaining license extensions beyond the present 40 year limit.

- Progress must be made to find a final repository for the radioactive wastes from nuclear plants and to dispose effectively of low and intermediate level radwastes as well as mixed wastes.

- Advanced light water designs which meet utility (owner-operator) requirements for even greater safety, reliability and economy must be completed and certified by the NRC to serve as the standardized plant for initial expansion. Importantly, certification must be granted in a timely manner in order that nuclear becomes an option in the mid-1990's.

- Plant sites on which such plants can be built must be selected and approved.

- Work must proceed to develop the advanced gas-cooled and liquid metal-cooled systems to fulfill the potential of nuclear power to broaden its energy applications and to sustain its fuel supply.

The Next Increment of Nuclear Capacity

As indicated by these key points, from the viewpoint of the industry, the utilities must have a strong sense of certainty in the performance, safety, and operability as well as the licensing process of future nuclear power plants. To help achieve that objective, the utilities, through EPRI and working with the Department of Energy and the Nuclear Regulatory Commission, are making known their performance and safety requirements for future plants. Table 2 contains estimates of the expected performance and costs of existing and advanced nuclear technologies.

It is the present judgement of the majority in the nuclear power industry that the light water reactor (LWR) will remain the dominant nuclear power technology for the next several decades. Over 25 years of favorable operating

experience worldwide, along with extensive development and testing programs, support the LWR and provide a sound basis for confidence in this concept. Moreover, the industrial infrastructure to support the LWR is well established. Thus, an improved version of the LWR is expected to be the preferred choice for the next increment of nuclear capacity ordered in the United States.

Advanced LWR Development

The advanced LWR program, presently sponsored jointly by the utility industry, both domestic and international, and DOE, offers the most promising approach to developing the next generation of nuclear power plants. This program has three objectives. The first is the development of utility requirements for future LWRs to achieve an increase in safety by a factor of 10, increased lifetime reliability, reduced capital costs, shorter construction time, and lower operating and maintenance costs. A substantially simpler plant design is also called for to help achieve the safety, reliability, and cost goals. The second objective is to obtain NRC certification of the designs of large (1300 MWe) evolutionary BWR and PWR plants based on these utility requirements, as well as on the detailed design data and testing base from which the evolutionary design have been derived. The third objective is to develop the option for an economical smaller and simpler PWR and BWR--with a power output of 600 MWe; and to obtain NRC certification of the designs based on the utility requirements, the extensive LWR operating experience base, and greater use of natural processes for core and containment cooling.

The utility industry through EPRI has joined with DOE in defining a $200 million plus, six-year ALWR project to carry out the detailed design and testing of passive cooling features of these two concepts with the final objective of achieving NRC certification of both designs by 1996. Contracts have been awarded to General Electric and Westinghouse to initiate the detailed design work, along with supporting contracts to architect-engineers and other utilities.

In addition to this advanced LWR work, advances in other nuclear reactor concepts should be pursued. Based on results of the conceptual design and preapplication licensing review, the modular high-temperature, gas-cooled reactor (MHTGR) offers a different approach to nuclear plant construction and operation and can be ideal for process heat applications. Based on pilot plant

Table 2.

NUCLEAR POWER TECHNOLOGIES

Technology	Anticipated[A] First Year of Commercial Service	Equivalent[AB] Availability	Total[A] Plant Cost* ($/kWe)	Operating[A] Cost$ (mills/kWh)	R&D Cost* (M$)	First-Of-A-Kind Eng. & Siting Cost* (M$)
Existing LWRs (Baseline: 1989)		68%		8-46 (O&M: 3-37)		
Improved Performance of Existing LWRs (1991 & Beyond)		75%		O&M Increase Less than Inflaction		
Evolutionary LWRs	1998-2000	82.8%	1300	22 (O&M: 13)	0	250
Passive LWRs	2000-2002	85.6%	1475	25 (O&M: 16)	300	650
ALMRs	2006-2010+	80%	Required to be competitive with LWR Technology		2000	750
HTGRs	2006-2010+	80%			2000	750

*In 1989 dollars - Does not include interest during construction and owner costs.
$Actual cost for 1988.

SOURCE: A. Projections from Technical Assessment Guide, Vol. 1, 1989. EPRI report P-6587
Also Advanced Lightwater Reactor, (Utility Requirements Document), EPRI March 1990.
B. Consistent with Design Availability Target of 87% Cited in ALWR Documents.

testing, the advanced liquid metal cooled reactor (ALMR) system also offers a different approach which will ultimately assure abundant nuclear fuel supplies in the next century. Thus, it would be prudent to develop the MHTGR and ALMR as potential nuclear options for the future.

MHTGR D[illegible]opment

The goal of the MHTGR Program is to achieve economical, safe, reliable power through the use of an innovative modular design with a reactor module power output of 140 MWe. The present DOE plan is to pursue final design approval of a standard four-module nuclear island by 1996. Utility/user support is currently organized through Gas-Cooled Reactor Associates (GCRA), with supplemental technical support by EPRI. This private-sector interest and potential to build a lead plant is required to complement the DOE program such that certification and commercialization can be realized. The design, the material properties and operating characteristics of the MHTGR result in enhanced safety margins without reliance on AC-power safeguard systems and/or operator actions.

Advanced Liquid Metal Reactor Development

If economic competitiveness is achieved, this system could be deployed commercially in the next century. Then, as increased reliance on lower-grade uranium resources forces prices upward, the LMR would become, in the 2030-50 time range, increasingly attractive as a power producer because of its vastly superior fuel utilization efficiency, especially when used as a breeder.

As things stand now, the United States lags behind France, the Soviet Union, and the United Kingdom in construction and operation of large LMR plants. Japan is moving aggressively into a competitive position with construction of a 250 MWe LMR demonstration plant (Monju). DOE's advanced reactor program has traditionally involved limited exchanges of technical information with countries overseas who are conducting a advanced reactor development programs. The European community has banded together in a shared R&D program on the LMR system, but the U.S. LMR program does not have access to the detailed design, construction, and operational experience being gained in Europe, nor in Japan.

Summary

Electricity is an energy form that provides a unique capability for reconciling the nation's economic and environmental objectives while improving quality of life. The challenge is to achieve a higher quality of life through environmental and public health improvement while assuring a higher quality of living through reliable, low-cost electricity. The highest priority in the development of the needed capacity should be to satisfy stringent environmental and public health standards. The systems that emerge will be those that meet those standards and are cost-effective. Government policies should therefore promote the development of those systems such as renewables, clean coal technologies, and nuclear power that show great promise in that respect. Governmental policies should also foster international cooperation in energy R&D, environmental controls, and safety standards.

Specifically with respect to nuclear power, the Federal Government through legislative activity, budgetary priorities supporting energy R&D, and through the actions of its agencies such as the NRC, the EPA and the DOE must exercise a leadership role in ensuring that nuclear power contributes to this society's economic and environmental goals to its fullest potential.

THE DECLINE OF NUCLEAR POWER:
THE OUTLOOK FOR THE NINETIES AND BEYOND

TESTIMONY SUBMITTED TO

SUBCOMMITTEE ON NUCLEAR REGULATION

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

AUGUST 1, 1990

CHRISTOPHER FLAVIN
VICE-PRESIDENT FOR RESEARCH

WORLDWATCH INSTITUTE
1776 Massachusetts Ave. NW
Washington, D.C. 20036

Thank you Mr. Chairman for the opportunity to present testimony on the future role of nuclear power in the United States. I am Vice-President for Research at Worldwatch Institute in Washington, and have been following nuclear power trends both in the United States and internationally for the last ten years. In that regard, I have published a number of reports and presented testimony to government inquiries in several countries.

I would like to start by describing recent trends in the nuclear industry since it is only by understanding its problems that one can accurately assess the chances of a revival. I will then turn to the question of future electric power needs, the impact of environmental considerations, and the factors influencing future nuclear expansion. In sum, it is my judgement that nuclear power will not prove a viable solution to global warming--nor even a reliable addition to the country's electric supplies in the years ahead.

It has been 12 years -- since 1978 -- that the United States has not ordered a nuclear plant of any kind. And one must go back even further -- 16 years to 1974 -- to find a nuclear plant that was ordered and not subsequently canceled. Indeed, between 1976 and 1989, 108 nuclear plants were canceled by utilities, representing 122,000 megawatts of generating capacity, which is more than the country's total current nuclear commitment.

During the past few years, construction has wound down on the few remaining nuclear facilities that were begun in the mid-seventies. While these completions have added slightly to total nuclear generation, they also mark the end of the era of post-war nuclear construction. As we sit here today, there is only one U.S. nuclear plant under active construction -- the Comanche Peak facility in Texas. While there are another eight partially built plants in "mothballs," most of these are unlikely ever to be finished.

Total nuclear power capacity in the United States is likely to peak in the next year or two at about 100,000 megawatts and then begin to decline as aging nuclear plants are retired. Indeed, ten plants have already been shut down, most of them well ahead of schedule. It now appears that the nuclear share of U.S. electricity production will peak at about the current level of 20 percent.

While nuclear advocates argue that the situation in the United States is an isolated exception caused by mismanagement, worldwide trends belie this argument. Indeed, the past decade has witnessed a tide of rejection of nuclear power by countries around the world. This international trend is propelled by a series of technical mishaps, the two serious accidents at Three Mile Island and Chernobyl, rapid cost escalations, and rising concern about a healthy environment. From Europe to Asia, the public is particularly concerned about the dangers of accidents and a continuing failure to develop safe means of disposing of nuclear wastes. Opinion polls in most countries indicate lopsided majorities against the construction of additional reactors.

Many governments and utility companies have responded to these changes by drastically curtailing their nuclear power programs or canceling further expansion entirely. While nuclear proponents frequently refer to the expansionist plans of France and Japan, these two countries are minor exceptions to the global trend, and even their nuclear programs are now in jeopardy, due to public opposition in Japan and the near bankruptcy of the state utility in France.

Among the countries where construction has ceased entirely are Italy, Spain, Sweden, Switzerland, and West Germany. Great Britain, like the United States, has just one reactor under construction. Future plans were abruptly

canceled last year when in the course of privatizing the power industry it was found that nuclear plants are costing about twice what the government claimed.

Nuclear construction in France is now predicted to end as soon as 1993 when the country's last batch of nuclear orders are scheduled for completion. In the Third World, there are only 16,000 megawatts of nuclear plants in operation--5 percent of the world total. Many of them are seriously over budget and plagued by technical problems. There have been only a handful of Third World orders in the past decade.

As the western world turns away from nuclear power, Eastern Europe and the Soviet Union account for a disproportionate share of the plants remaining under construction. Not surprisingly, these nuclear programs are among the first victims of perestroika. Nuclear power is extraordinarily unpopular in the post-Chernobyl environment, and the plants themselves are far from meeting western safety standards. In Eastern Europe, several operating plants have been shut down, and plants under construction are being reconsidered.

The Soviet Union's nuclear orders ceased at the time of Chernobyl, and the centrally planned construction program is now under attack -- both by the scientific community and a new generation of political leaders. Russian Republic President Boris Yeltsin shocked the country's nuclear industry this June when he reportedly ordered the suspension of construction in Russia.

Today, there are less than 80 nuclear plants under active construction worldwide, a third as many as a decade ago. Moreover, many of these are in the completion phase so that in the next few years worldwide nuclear expansion will slow to a trickle. It now appears that in the year 2000 the world will have at most 400,000 megawatts of nuclear capacity, compared to the 4,450,000 megawatts forecast by the International Atomic Energy Agency (IAEA) in 1974.

Moreover, unless there is an immediate turnaround in orders, by the year 2000 nuclear power generation will be declining rather than increasing.

Prospects for such a revival will hinge critically on the future market for electricity. In the United States, the average rate of growth of demand for electricity has fallen from 7 percent annually in the early seventies to an average of 2.4 percent per year from 1979 to 1989. With the overhang of excess power plant orders during the seventies, much of the country was burdened by expensive excess generating capacity throughout the eighties.

As plants were canceled and demand grew, the average reserve margin fell from nearly 40 percent in 1982 to 30 percent in 1989. While there are a few areas of the nation where the reserve margin is approaching the 15-20 percent figure needed to assure reasonable reliability, there is still ample capacity in most areas of the country. While reserve margins can be expected to tighten in some regions in the next 5-10 years, requiring plant construction or demand reductions, nuclear lead times are too prolonged to help.

The slowdown in electricity growth during the past 15 years stems from several developments. The first is structural change in the economy. Many of the most power-intensive industries declined in importance, while service sector industries flourished. At the same time, as electricity prices soared, many industries were able to improve their energy efficiency, reducing power needs. As a result, while gross national product increased 30 percent between 1979 and 1989, industrial electricity use increased only 9 percent.

The use of electricity in residential and commercial buildings has increased more rapidly, spurred in large measure by growth in the numbers of buildings. But here too there has been a slowdown as the penetration of some electricity consuming devices such as air-conditioning has neared saturation.

Meanwhile, the energy efficiency of many of these devices has improved significantly, cutting power requirements. One of the few areas where electricity use has outstripped the underlying rate of economic growth is in office buildings, where the proliferation of computers, laser printers, copy machines, and so on has spurred power demand. But the efficiency of many of these devices continues to improve, which is likely to offset future growth.

Overall, electricity demand growth is now consistently lagging behind economic growth. While the GNP went up 30 percent between 1979 and 1989, total electricity use went up just 24 percent. The divergence between these two trends is likely if anything to widen in the years ahead--due principally to the accelerating trend of improved energy efficiency.

Many energy-efficient technologies have just begun to catch on. The next decade could well see the proliferation of compact fluorescent light bulbs that are nearly four times as efficient as the incandescent bulbs on the market today. The Rocky Mountain Institute has calculated that this and other new lighting technologies could save over 100,000 megawatts of power, enough to displace the entire nuclear generating capacity of the United States.

In existing commercial buildings, improved windows, lighting, and air-conditioning can reduce power requirements by 50 percent, while in new buildings they can be reduced 75 percent. More efficient refrigerators and other household appliances could cut power requirements by 50 percent or more. In industry, the biggest savings are likely to be realized via improved motor drives, which can reduce typical power needs by upwards of 40 percent. Nationwide potential savings of at least 60,000 megawatts are plausible.

Beyond the enormous technical potential to improve energy efficiency, the business and regulatory environment is likely to prove more conducive to

achieving that potential than in the past. Utility investment patterns are heavily influenced by the policies of state regulatory commissions, which determine the level of profits and how those levels are determined. Until recently, the system has been heavily weighted to encourage large central station power plants.

That bias is now rapidly ending, due in no small part to public reaction to the nuclear cost overruns of the seventies and eighties. Both utility companies and state regulators are determined to pursue more cautious, deliberate investments, avoiding the risky behemoths that they were burned by in the past. One strategy that is being pursued in a growing number of states is for utilities to invest directly in improved energy efficiency, a trend that has enormous potential to slow electricity growth rates.

In the past, utility profits were directly tied to the level of power sales, a strong dis-incentive to investment in improved efficiency. While some utility commissions, as in California, have mandated direct investment in improved efficiency, utilities did not find it profitable and so reduced their commitment as quickly as they were allowed to.

The solution to this dilemma is found in the new concept of incentive-based regulation--intended to reward utilities for pursuing the most cost-effective investments, including improved efficiency. One approach is to provide a higher rate of return on efficiency investments. Another is to make the utility's overall rate of return dependent on the cost-effectiveness of the service it provides customers. Thus, a strategy such as improved efficiency that lowered costs would also raise profits.

Incentive-based regulation has been officially endorsed by the National Association of Regulatory Utility Commissioners and is being employed on a

limited scale in several New England states. About a dozen additional states, including California and New York, are considering similar schemes.

Experience in New England so far suggests that such incentives can lead to a strong commitment to improved energy efficiency and an annual investment of between 5 and 10 percent of utility revenues in such programs. (On a nationwide basis this would result in between $10 and $20 billion being spent on improved efficiency each year.) With such programs, electricity demand can be reduced by 2 percent annually, largely offsetting the underlying rate of growth of at most 2.5 percent annually.

Further spurring efficiency is the movement to incorporate environmental costs into the utility regulatory equation. New York has moved the furthest by assigning an environmental cost of 1.4 cents per kilowatt-hour to proposed new fossil fuel-fired power plants. This would be added to construction and fuel costs in considering bids to build new fossil plants, making improved efficiency appear even more attractive. California, Wisconsin, Oregon, and Maine are considering similar proposals. Some have argued that environmental fees should also be levied against proposed nuclear power plants.

Mandatory efficiency standards will also have a restraining influence on future electricity demand. In California, where home appliance standards were pioneered in the mid-eighties, electricity growth per consumer has fallen much more steeply than for the nation as a whole. Federal appliance efficiency standards were finally enacted in 1987 and are just beginning to have a similar impact. While the precise effect of these and other standards is hard to predict, they will clearly reduce projected demand.

Efficiency improvements will substantially reduce the numbers of power plants needed in the future. However, some new generating capacity is likely

to be needed -- to replace today's aging power plants if nothing else. Recent trends suggest that this next generation of plants is unlikely to be nuclear-powered.

The first reason is cost. The U.S. business magazine Forbes has called the nuclear industry "the largest managerial disaster in U.S. business history," involving $100 billion in wasted investments and cost overruns, exceeded in magnitude only by the Vietnam War and the current S&L crisis.

The average cost of new nuclear plants has now risen to $3,500 per kilowatt or more than $4 billion for most recently completed single unit plants. This compares to costs of $200 per kilowatt in the early seventies and $750 per kilowatt in 1980. Even after adjustment for inflation, real nuclear construction costs have increased sixfold since the early seventies.

Beyond the rise in construction costs there is an equally worrisome increase in the operating costs of U.S. nuclear plants. These costs have increased threefold in the past decade even after adjusting for inflation, reaching 2.18c per kilowatt-hour in 1987. Total operating and fuel costs of nuclear power plants in the United States now slightly exceed those of coal-fired plants, which were 2.07c in 1987.

These costs of $10 billion annually reflect a technology that has not yet been stabilized, requiring large amounts of unplanned maintenance, equipment replacement and capital additions. Indeed, this enormous unexpected repair business is the only thing keeping the order-short nuclear industry alive.

Combined operating and construction costs yield an annual levelized cost for new nuclear plants of at least 12c per kilowatt-hour. This is well above the equivalent costs of new coal- gas- and even wind-driven plants being built in the United States. It is hardly surprising that these huge costs have

encouraged state utility commissions to look skeptically at nuclear power and for many utility companies to state publicly that they have no interest in even considering nuclear investments.

The trend in the utility industry today is not only away from nuclear power but away from central station power plants of all kinds, including coal plants. Whereas such plants were once assumed to be more economical than smaller faciiities, they have recently been plagued by rising costs, particularly for pollution controls. Moreover, large plants require large investments and take many years to build, a risky equation given the uncertainty of electricity markets today.

Since the mid-eighties, central station orders have virtually ceased, replaced by smaller, decentralized facilities, many of them owned and operated by independent power companies. The utilities themselves need not invest any capital, but simply contract to buy the power. California alone already has 10,000 megawatts of independent generating capacity, representing one-sixth of the state's total. All of it was built in a single decade.

The resulting plants range from natural gas-fired industrial cogeneration systems to fluidized bed and combined cycle coal plants. Also prominent in the mix are wood-fired power plants, municipal waste-fueled facilities, wind farms, and solar power plants. Already, the average size of a new U.S. power plant has fallen from over 500 megawatts in the early eighties to less than 50 megawatts in the early nineties.

There is little reason to think that this trend will suddenly reverse. The utility planning environment remains highly uncertain, and the cost of the decentralized power alternatives continues to fall. Just as with efficiency programs, a growing number of states are altering the regulatory rules to

ensure that utilities do not ignore cost-effective independent power alternatives in favor of their own central station plants.

The days of a centrally planned monopolistic utility system are numbered. While precise economic regulation and fixed rates of return were arguably the fastest way to create a large electric utility industry from scratch, they are no longer capable of providing for the varied needs of today's societies. Nuclear power, with its long lead times, huge capital costs and numbing uncertainties is unlikely to flourish in this new environment. Indeed, both regulated utilities and the new independents seem to implicitly recognize that trying to build a nuclear plant today would be like playing a risky and unnecessary game of "Bet your company."

An additional factor weighing against new central station power plants is the difficulty of finding acceptable sites for them. As environmental sensitivities have grown, so has local opposition to large power plants. Increasingly, communities are unwilling to accept a large environmental impact in return for the relatively few permanent jobs at a new power plant. Utilities prefer if possible to avoid the storm of controversy that ensues when a large new power plant is announced.

Finding sites for nuclear plants is particularly problematic. They must be located near large bodies of water for cooling, on a flat site, and away from areas of seismic activity. Public attitudes are somewhat uncertain since the last time a nuclear plant was sited was almost 20 years ago. Suffice to say that public opinion on such matters has shifted dramatically during this period. It is now difficult to obtain a permit to locate a new landfill or manufacturing facility, let alone a nuclear plant. Any effort to build large numbers of reactors would be strenuously opposed by many local communities.

11

It is safe to predict that beyond two or three of the partly built plants now sitting in mothballs, there will be no additional nuclear plants completed in the United States before the year 2000. There simply is not enough time left. The decade from 2000-2010 could conceivably see some nuclear expansion, but only if conditions change rapidly. Even for that decade, the industry would have to rely on today's technologies, though possibly with some greater degree of standardization.

Assuming that some construction does occur during this period, the first 20 plants would probably be needed just to replace the ones likely to face early retirement between now and then. It seems quite unlikely that before 2010 there will be a significant addition to the country's nuclear industry, let alone the production of enough power to offset a significant amount of carbon dioxide and help to slow global warming. Indeed, accounting for retirements, it would require the construction of at least 60 nuclear plants by 2010 just to reduce U.S. carbon dioxide emissions by 5 percent.

The longer term hope of the nuclear industry is the creation of a new generation of so-called "inherently safe" reactors. This concept, which has quickly gained adherents in the past few years, is rooted in the notion that the industry's problems are caused by the high costs, unreliability, and licensing difficulties of today's technologies.

At least eight new reactor designs have been proposed, and while they vary considerably and offer a number of intriguing features, they all share an important characteristic: they are raw, untested concepts that raise a host of technical problems that could well take decades to resolve. Indeed, thirty years into the era of lightwater reactors, engineers are still finding new and unexpected problems with them.

12

A recent study of three of the proposed reactor designs by the Union of Concerned Scientists found that none can properly be described as "inherently safe" since they are vulnerable to catastrophic accidents that can only be avoided by the successful operation of "active" safety systems. And just as with Three Mile Island and Chernobyl, these reactor designs appear not to be immune to human mistakes.

While new reactor designs have been trumpeted loudly in the press, they are a good deal further from realization than most policy makers seem to realize. None has advanced beyond the level of early engineering studies, which makes it difficult to anticipate production problems and impossible to make accurate cost projections. The industry is in one sense proposing a 30-year step backwards. Complicating the picture is the fact that several designs are competing, which means that no individual design is receiving sufficient support for the engineering to progress steadily.

If the federal government were to settle today on a proposed reactor design, that would only begin the process. At least three years of paper engineering studies would be required, followed by a minimum of eight years to build a prototype reactor (even established commercial designs take a minimum of six years to build). That reactor would then have to be tested for at least three years before work could begin on commercial reactors. If the experience with light water reactors is any guide, it would then take 15-20 years to build a sizable contingent of say 50 power stations.

The total time involved would therefore be 30-35 years. And this assumes that everything goes reasonably well, that the nuclear waste problem can be solved, that sites can be found for all of these reactors, and that some new combination of technologies has not meanwhile made nuclear power obsolete.

Perhaps most striking is the fact that all of these stations would simply be needed to replace today's reactors, most of which will be shut down 35 years from now. No net reduction in carbon dioxide emissions would result. For nuclear power to make a real dent in the total output of greenhouse gases would require the construction of several hundred plants in the next few decades--a clearly preposterous figure.

This is the kind of program that could only be sold to a government. And indeed, even the strongest proponents of new reactor designs show surprising reticence to invest their own money. These designs will go nowhere unless Congress is willing to spend several billion dollars on their development.

My own tendency is to recommend caution--and at minimum substantial cost-sharing by private industry. The Department of Energy is already spending a disproportionate share of its budget on nuclear power, and the history of DOE mismanagement of nuclear mega-projects provides no reason for complacency.

In sum, nuclear power has over the past 15 years gone from a near-term, conventional option to one that is problematic and long-term at best. It provides no immediate or reliable solution to any of the pressing economic or environmental problems that the country faces. Indeed, a potentially mismanaged nuclear program could deepen the country's economic problems while further fouling the environment.

Congress' main role in all of this should be to ensure that existential debates over the future of nuclear power do not turn into a multi-billion dollar boondoggle for the American taxpayer. I would recommend concentrating instead on the unresolved first generation of nuclear problems--obtaining safe and reliable operation of the country's reactors, and permanently disposing of nuclear wastes. Thank you Mr. Chairman.

○